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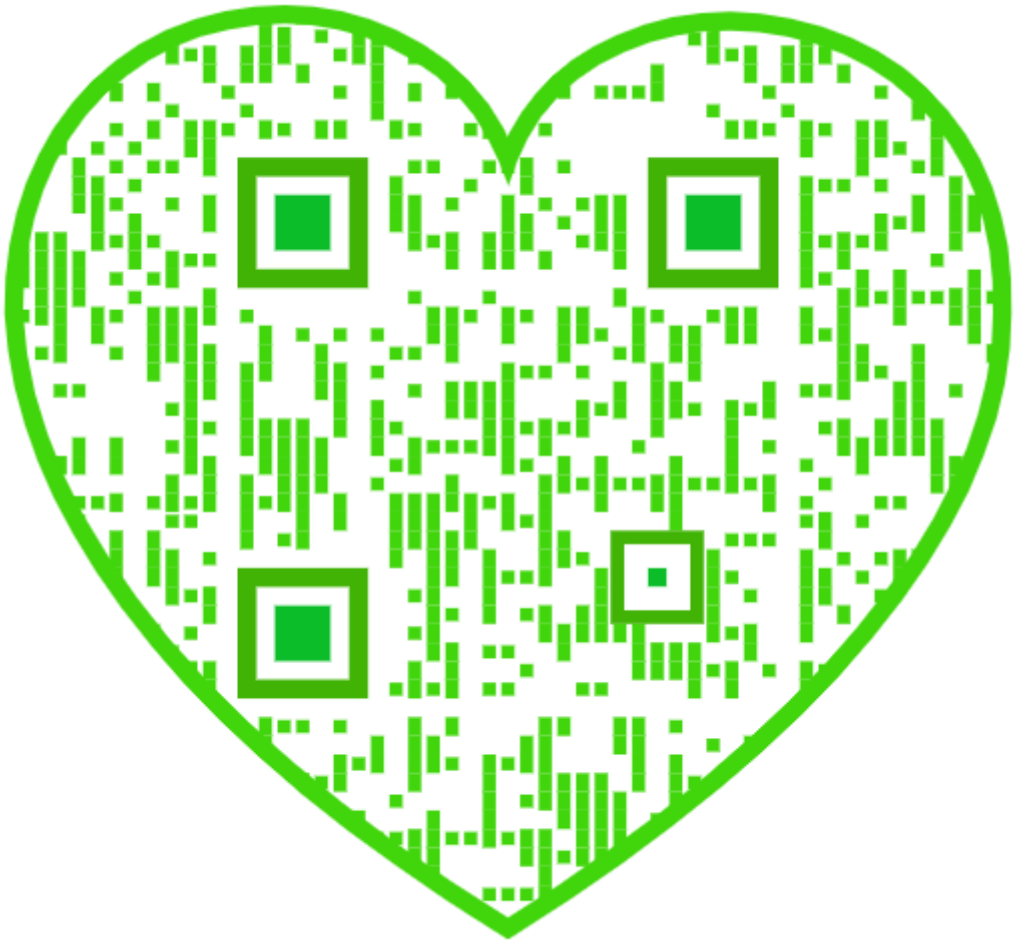
THE MANUFACTURE OF BOOTS AND SHOES

F. Y. GOLDING



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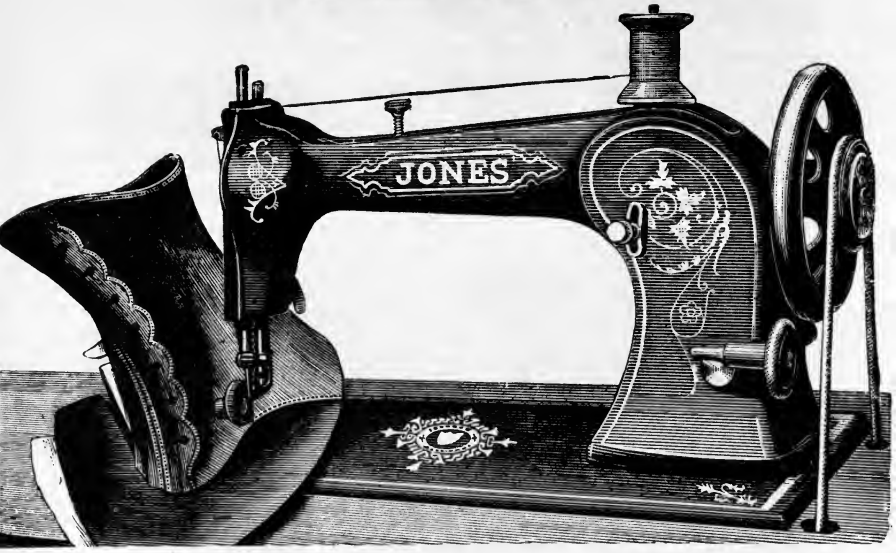

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THE MANUFACTURE

OF

BOOTS AND SHOES

BEING A MODERN TREATISE

OF

ALL THE PROCESSES OF MAKING
AND MANUFACTURING FOOTGEAR

BY

F. Y. GOLDING

PRINCIPAL OF THE CITY AND GUILDS OF LONDON INSTITUTE'S LEATHER TRADES SCHOOL

WITH OVER TWO HUNDRED ILLUSTRATIONS

LONDON
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1902

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GENERAL

PREFACE

THE aim of the Author in writing this treatise has been to produce a text-book useful to students attending technological classes, so that they may be enabled to supplement their knowledge gained in the class-room, and thus assist the instructor to cover a larger field than is possible under ordinary circumstances. It will also serve, it is hoped, as a handbook to some instructors by suggesting matter for teaching and demonstration in their classes.

To those unable to avail themselves of the advantages offered by the various classes held throughout the country, the work will be interesting and instructive.

It is to be noted that the book has not been prepared for use as a "cram" book, and care has been taken to treat the various subjects to minimize any such tendency.

The Author's best thanks are due to those who have lent blocks, etc., for use in this and the second volume.

LONDON,
1902.

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THE MANUFACTURE OF BOOTS AND SHOES

CHAPTER I.

THE CONSTRUCTION AND COMPOSITION OF THE FOOT.

Historic Introduction.—It is difficult to precisely ascertain the period when foot-gear was first worn. Ancient writings bear evidence that some protection or covering was in use, and it is certain that the custom is at least three thousand years old. The earlier productions were no doubt confined to a protection for the sole of the foot. Sandals are in

Fig. 1

Fig. 2.

existence, of Egyptian origin, that are supposed to date back to B.C. 1500. The Romans wore shoes of various heights and shapes, according to the status of the wearer, and it is interesting and instructive to study the history of boots and shoes of the ancients, but is not within the scope of this work. Fig. 1 will give an idea of a Roman shoe, and Fig. 2 of an Anglo-Saxon shoe. Those who wish

to be acquainted with the various shapes worn in earlier English periods should consult a work by Mr. W. H. Dutton, entitled, "Boots and Shoes of our Ancestors." *

The Importance of a Knowledge of the Construction of the Foot, in the production of modern foot-gear, can be best shown by Fig. 3, where it will be noted how the foot may be malformed through improper clothing. An acquaintance with the object covered would enable the covering to be suitably adapted to its requirements, and even, in the case of fashionable boots and shoes, would assist in the designing of more comfortable productions. There are several

Fig. 3.

branches of science that may be studied with advantage, such as anatomy, osteology, physiology, etc.

The anatomy of the foot is the study of the component parts of the foot—muscles, bones, tendons, ligaments, etc.—parts separated one from the other by dissection, in order to examine their shapes, relations, and connections. The study may be proceeded with in various ways: (1) by seeking the resemblances and differences that exist in the pedal extremities of animals of different species; (2) by practically seeking out the arrangements of the foot; or

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(3) by examining the composition and position of the parts of the foot as they influence its external form. The latter form of study would appear to be the most useful to the shoemaker; but, as the foot does not remain in a position of repose during its usage, it ought to be supplemented by a knowledge of the changes of form that take place during its various movements. The causes that determine these changes should be understood, and therefore it will be of advantage to have a certain amount of information of the parts of the foot.

The shoemakers' ideas that should be sought for in the study of anatomy are the ideas of proportion of the foot, of form, and of the various attitudes and movements. This is necessary to enable intelligible modifications to be made for the various kinds of shoes used for different purposes, such as walking, running, dancing, and cycling. Form is determined by bony prominences, and sometimes by the softer parts, either muscular or tendinous. The bones alone should furnish the marks from which to take measurements, and therefore proportions cannot be defined without an exact knowledge of the skeleton of the foot. This information will prevent mistakes being made in the apparent changes of proportion when certain movements take place. The *feel* of the external bony parts and their relation is also useful.

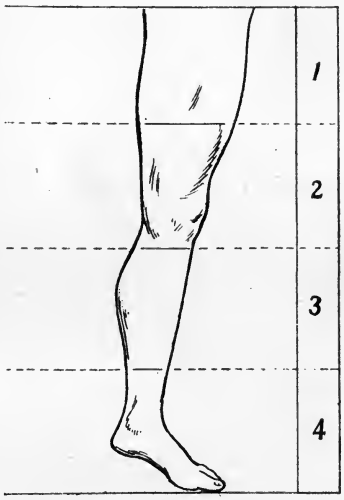


Fig. 4

Division of the Subject.—The bony structure of the lower extremities will be dealt with, also the joints, ligaments, arches, mechanics, muscles, positions of

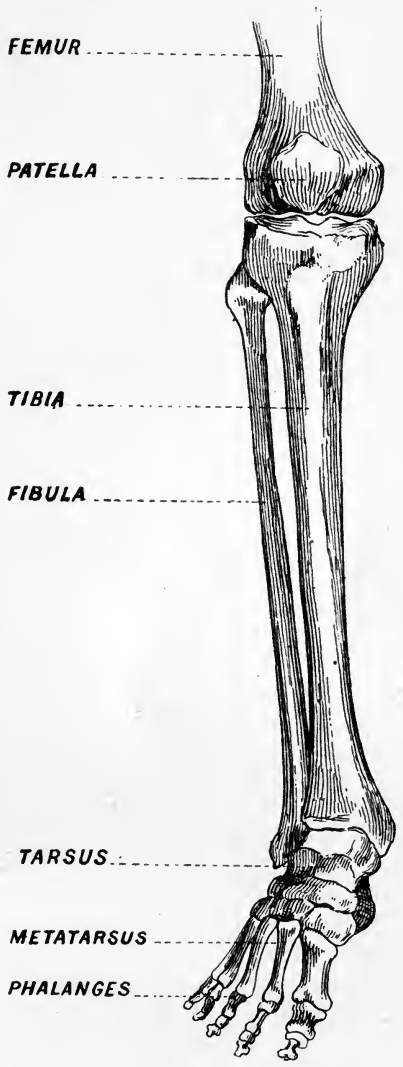
standing and walking, and the lessons to be derived therefrom.

The Lower Limbs occupy the lower half of the figure, and are the means of support and locomotion. The proportion they occupy relatively to the whole figure will be seen by reference to Fig. 4. They are larger and more powerful than the upper limbs, and give proof of the erect position being natural to man. The bones that comprise each limb are twenty-nine in number—viz. the *femur, tibia, fibula,* seven *tarsal* and five *metatarsal* bones, and fourteen *phalanges.* Professor Humphrey made an average of twenty-five European skeletons, and found the height to be 65 inches; and of this the femur (thigh-bone) occupies 17·9 inches, the tibia (leg-bone) 14·4 inches, the foot 10·6 inches. The bones of the thigh at the hip are about a foot apart, and as they descend they slant inwards, nearly touching each other at the knee.

The Study of the Bones is termed Osteology. Some of the terms used simplify the description, such as *anterior* portion of a bone—so described when viewing the bone from the front of the body; *posterior,* when viewing from the back. The long bones in the limbs act as axes, and are composed of two parts—the *body,* or *shaft,* and two extremities, or *epiphyses.* The small bones in the foot are somewhat wedge-shaped.

Uses of Bones and their Properties.—The bones support the soft or fleshy parts of the limbs, and form a framework that gives them shape. They form, in some cases, levers upon which the muscles act, and give origin to the various motions of the leg and foot. When dead bone is examined it is a hard-looking, whitish-yellow, tough substance. It is light in weight when compared with its strength. In its living state it has a pinky colour, due to the blood circulating through its minute channels. The exterior of the bone is cased—except when covered by cartilage—with a thin, firm membrane. If this membrane is injured, local death takes place in that part of the bone, because of its being

deprived of its nutrition. This membrane also affords means whereby the muscles, tendons, and ligaments may be attached to the bone. It forms a smooth surface to the bone, and so reduces friction; so that its use is threefold: (1) to act as a medium to convey nutriment to the bone it covers; (2) to lessen friction; and (3) to provide a means of attachment for muscles, etc. If a piece of bone be examined under a microscope it is seen to be filled with an infinite number of minute canals containing blood-vessels, and it is through these little tunnels that the bone is built up and nourished.



The bones at the commencement of their formation are composed of *cartilage*, or gristle, and are gradually made into bone by the earthy salts being deposited through the blood-vessels, thereby imparting rigidity to the cartilage. In childhood bones are made up of parts which do not unite until maturity is reached, so that it is easy to bend or misshape them.

Composition of Bone.—The animal or organic materials that compose bone are about one-third of the bulk, the remainder being made up of inorganic constituents or earthy salts. The animal substances impart flexibility, and the earthy salts hardness, to the bone. The bones of children are softer and more elastic than those of older persons, and so are easily bent. In old age there is a preponderance of inorganic compounds, so that the bones are brittle and liable to fracture.

The Femur, or bone of the thigh, is the largest bone in the body, and it transmits the weight of the body to the knees. Fig. 5 gives a sketch of the front view.

Fig. 5.

The Two Bones of the Leg, the tibia and the fibula, are different in their size, and are placed parallel to each other—the tibia on the inner side and the fibula on the outer (Fig. 6). The tibia, or shin-bone, the larger of the two, is triangular in section, and receives the weight of the body from the thigh-bone and carries it to the foot. Its direction is vertical, and in well-formed legs the two bones (tibiæ) are parallel. At the top front portion it is very sharp and easily felt beneath the skin. The lower end is expanded across to form a joint with the astragalus. It is also, at the lower end, more forward than the fibula; so that the inner and outer ankle are not in the same transverse plane. The outer upper edge of the tibia gives origin to the *Tibialis anticus*, and behind the *Flexor longus digitorum*, and the *Tibialis posticus*.

The fibula, or clasp-bone, is situated on the outer side of the leg and a little behind the tibia. It is as long as the shin-bone, but more slender and does not sustain weight. At its upper end it is not level with the knee-joint, of which it forms no part, and at its lower end it

is considerably below the tibia, forming the outer ankle (Fig. 6). The muscles that are associated with this bone are *Peroneus longus, Extensor proprius pollicis, Flexor longus pollicis.*

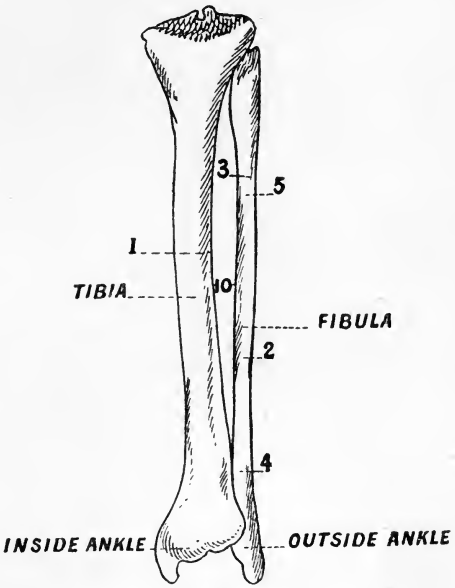


Fig. 6.

The Bones of the Foot are twenty-six in number, and consist of three groups—the tarsal, metatarsal, and phalanges; also termed ankle, foot, and toes respectively. The advantage of so many bones forming the foot, with a number of joints, is that motion and elasticity are increased, while the chances of dislocation or fracture are lessened. The bones of the tarsal region are short, thick, and compact. In front of them are the longer bones, that diverge a little as they run forward. The bones of the toe are mobile (Fig. 7).

The Tarsal Bones are seven in number—two backward, and the others anterior. Of the two posterior bones, the os calcis extends backwards, and forms the projection of the heel. Above the heel-bone is the astragalus, which alone is united to the leg-bones. In front of the astragalus is the scaphoid, and still more forward are three cuneiform bones, to the outer side of which is situated the cuboid (Figs. 7, 8, and 9).

The Os Calcis, or calcaneum, is the largest and strongest

of the tarsal bones, and transmits the weight of the body to the ground posteriorly. It also affords attachment for the tendon of the muscles of the calf. At its upper forward surface it supports the key-bone of the foot. It is sometimes thought that the negro has a longer heel than the white man; but the apparent lengthening is due to the smallness of the calf, rather than to any diminutive construction of the os calcis. This bone gives origin to the *Extensor brevis digitorum.* There is a deep groove running along its under surface for the tendon of the *Flexor longus pollicis.* Other muscles arising from this bone are—*Abductor pollicis, Abductor digiti minimi, Flexor brevis digitorum.* There are fixed to this bone three strong ligaments, to preserve the arch of the foot (Figs. 8 and 9).

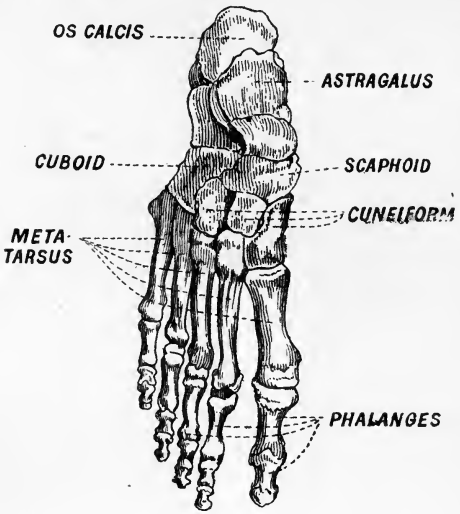


Fig. 7

Fig. 8.

The Astragalus, or huckle-bone, is the keystone of the arch of the foot. The front portion of this important bone is received in the cavity of the tibia and fibula (Fig. 10).

The upper surface is one-fifth of an inch wider in front than behind, and this prevents dislocation backwards when running or jumping. There is an oblique groove which allows the tendon of the *Flexor longus pollicis* to run downwards and inwards. In front the convex head is received into a socket formed by the scaphoid, and below by the os calcis. On the inner side below a slightly elastic ligament is situated, filling up the gap left. This ligament mainly supports the arch of the foot, and gives its spring; and if it yields more than it should, down goes the arch, and the foot becomes flat (Figs. 8 and 9).

The Cuboid Bone is situated on the outer side of the foot. It has a groove on its under surface intended for the tendon of the long peroneal muscle that passes obliquely to the sole of the foot. It gives origin to two muscles, the *Adductor pollicis* and the *Flexor brevis pollicis*. The adductor arises from a sheath which bridges over the *Peroneus longus* groove.

The Scaphoid Bone is like a boat in form, and is placed on the inner side of the foot. It gives insertion to the tendon of the *Tibialis posticus*, which turns the foot inwards.

The Cuneiform Bones, three in number, are in front of the scaphoid, and anteriorly are met by the metatarsal bones. The cuneiform that is on the inner side of the foot is larger than the others, and gives, on its under side, insertion to two muscles that turn the foot inwards. It has a prominence that can be easily felt on the foot, and is sought after in taking measures.

The Metatarsal Bones, of which there are five, are long bones that are close together where they join the tarsal bones, but as they descend, separate slightly. The first, or inner bone, is short and strong, and supports the great toe. The second from the inner side is longer than the others, and should be specially noticed. In the skeleton of the foot, the bones just described form an arch that has two concavities—one from front to back, and the other across the foot.

The Phalanges of the toes, fourteen in number, are arranged three on each toe, with the exception of the great toe, which only has two, thereby giving greater power to the first toe. Under the first metatarsal bones are two small bones, termed sesamoid bones, which increase the leverage of the tendons that work the great toe.

The knowledge of the individual bones will be of little value, unless their relation be also studied as a whole.

Joints.—The surfaces of the bones that meet at joints are tipped with gristle, or a layer of cartilage fixed firmly to the bone. Between the cartilages is found a synovial membrane. This is a kind of bag containing a small quantity of lubricating fluid, termed synovia. In health there is only sufficient to enable the surfaces, which are smooth, to glide easily over each other.

The Ankle-joint is formed by the astragalus and the bones of the leg. Its use is to allow the foot to be flexed or extended, raised or depressed. It is a strong hinge-joint, and scarcely any lateral movement takes place. In fact, when the foot is at right angles to the tibia, no lateral movement is permitted, and only when the foot is bent does a slight lateral movement take place between the astragalus and the tibia, and this owing to the astragalus being narrower behind than in front. The tibia and fibula are united by a ligament, and when the foot is fully flexed, the larger front of the huckle-bone opens the tibia and fibula, and so exercises the ligament. The opening is not directly forwards, but slightly *outwards*, so that when feet are fully extended they incline to each other, and when flexed they decline. If a person stands on tiptoe, the ankles separate. If the position be changed to the heels, and the foot extended, the great toe of each foot will approach; and if flexed, they will diverge. This is an important fact to bear in mind in designing lasts for various-height heels, and such work as running shoes.

A second joint in the foot is between the astragalus and the os calcis. It is brought into play when the foot is moved from side to side. A third joint is between the astragalus and os calcis, and the scaphoid and cuboid, and allows the foot to be raised on the inner side and depressed on the outer side.

Ligaments are bands of flexible, tough, inextensible, somewhat silvery-looking, fibrous tissue; their office being to limit the movements of a joint. They often work alternately with the muscles, being of mutual advantage in preserving and developing strength in each other. The arch of the foot owes its shape largely to their aid.

The Plantar Ligament connects the os calcis with the metatarsal, and is often likened to the tie-beam of a roof, and has been supposed to be the means of maintaining the arch, although it would be more correct to say it assists the muscles in forming the arch, A, Fig. 8.

The Calcaneo-Scaphoid Ligament is another important ligament of the foot. It is composed of elastic tissue and supports the huckle-bone. The quality of elasticity is not common to other ligaments, and its usefulness consists in allowing the astragalus to descend a little when weight is borne upon it, and after it is relieved of weight it forces the key-stone again to its normal position, thus giving, among other provisions, elasticity to the step. Improper boots preventing the usage of the ligaments will cause them to deteriorate, and "weak ankle" and "flat foot" are exhibited. This ligament in use adds its share to the elongation of the foot (see B, Fig. 8). When the toes of the foot are turned out, the scaphoid bone is lowered, and the ligament uniting it to the os calcis is relaxed, so the astragalus lowers, and *vice versâ* if the toes of the foot are turned inwards.

There are other ligaments in the foot, such as the interosseus (Fig. 9) between the astragalus and the os calcis,

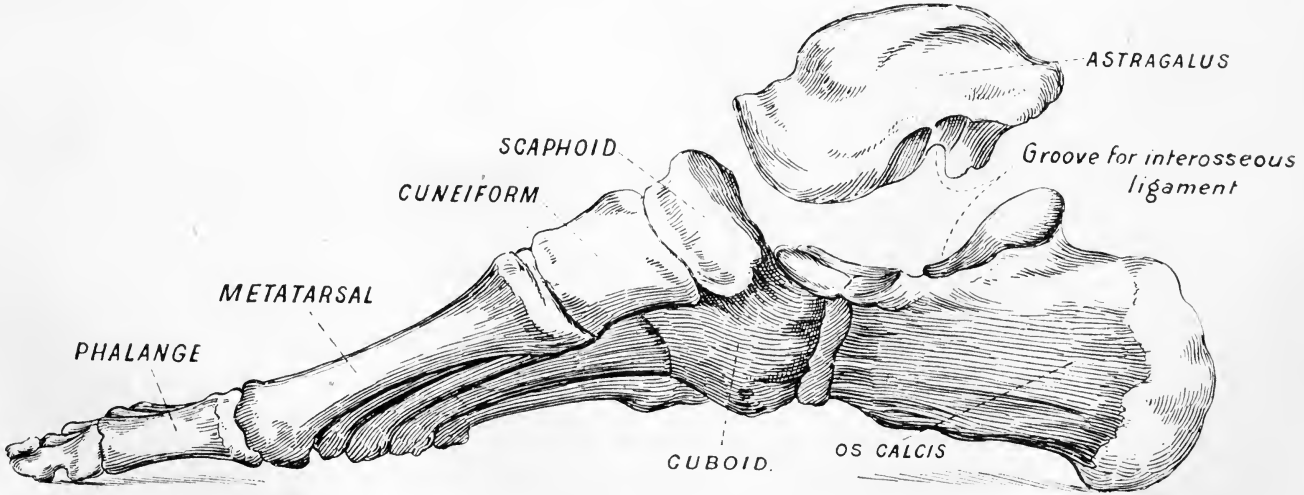

ASTRAGALUS
Groove for interosseous ligament
SCAPHOID
CUNEIFORM
METATARSAL
PHALANGE
CUBOID.
OS CALCIS

FIG 9.

and those between the cuneiform bones; also the annular ligament that binds the tendons to the bend or curve in front of the foot. The plantar fascia is a very dense sheet of fibrous tissue fastened to the heel behind and spread over the sole, and fixed to the bone at the ball of the foot. It should be borne in mind that constant pressure or strain on a ligament causes wasting, but that intermittent pressure promotes growth.

Arches of the Foot.—The bones of the foot form two arches, one longitudinal and the other transverse. The longitudinal arch extends from the os calcis behind to the heads of the metatarsal bones in the front, being situated in the long axis of the foot. Its height and span are greatest on the inner side, and the distance from the ground lessens towards the outside of the foot (Fig. 9). The impression made by standing on a flat surface with wet feet will show how much flatter the outside margin is than the inside. The arch is mainly supported by the calcaneo-cuboid ligament. It is complete in each foot, and the posterior pier or pillar formed by the heel-bone descends almost straight to the ground, whereas the anterior pillar slopes gradually to the ball of the foot (Fig. 12). The arch is therefore solid behind and elastic or springy in front.

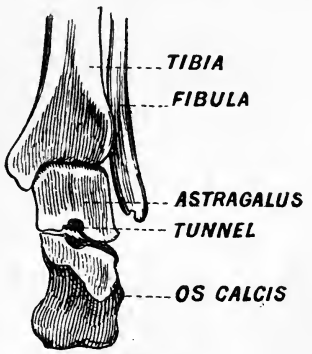


Fig. 10.

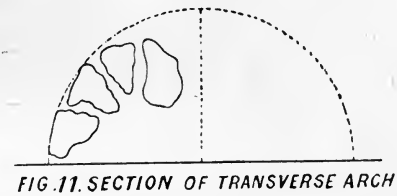


FIG. 11. SECTION OF TRANSVERSE ARCH

The transverse arch (Fig. 11) extends from side to side, and is most marked over the instep—that is, its convexity is across the cuneiform and cuboid bones. It forms half

a dome in each foot, with its greatest height on the inner side. Flat foot, or the bearing down of the arches, is most

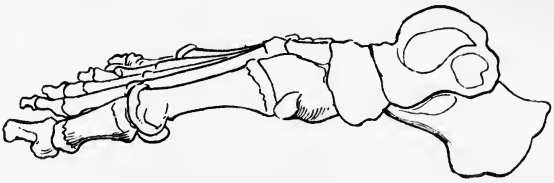


Fig. 12.

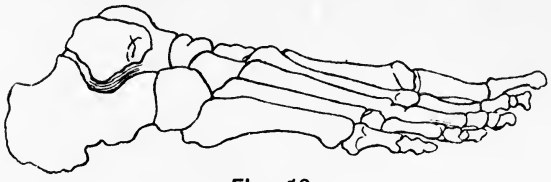


Fig. 13.

likely to be engendered—first, in infancy, if the child be put upon its feet too early, before the ligaments and bones are sufficiently developed to bear the weight of the body; and, secondly, about the age of fourteen, when the body attains a greater increase of weight. From what has been said respecting the ligaments, it will be seen that binding up the ankle in stiff leather coverings, or the making of stiff shanks to shoes, are not the methods best calculated to restore the arch of the foot. It will be well here to consider some

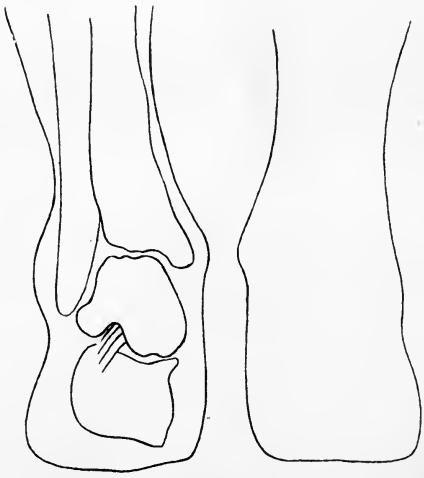


FIG. 14.

of the effects of the falling arch as it affects foot-gear. When the arch lowers, the os calcis is pushed backwards, making the foot long heeled; at the same time the astragalus advances towards the front, and adds to the foot's length. The leg thus has the appearance of being pitched more towards the middle of the foot. In a foot that is well arched, the projection of bone at the upper part of the heel-bone extends further back than the lower edge, and in a flatter foot the bottom part of the heel-bone extends further back than the upper. When weight is transmitted to the foot, the arches expand both longitudinally and transversely. The expansion of the long arch of the foot is greatest in high-arched, long, slender feet, and least in low-arched, short, strong, thick feet. The expansion laterally is greatest in high-arched broad feet, and least in low-arched narrow ones.

The Muscles supply the motive power by which the various motions of the leg and foot are performed. A muscle consists of red fleshy masses of fibre possessing contractile properties. It is soft and thick in the middle, and at each end tapers to a point, changing into a band by which it is fastened to the bones. It is a very active living substance, that is capable of shortening in one direction and thickening in another, under nervous action or stimuli. It does not alter in actual bulk, but only changes its direction. Muscle consists of bundles of fibres intermixed with nerves and blood-vessels. They are variously shaped, according to office, and are mostly attached to bones, which when movable are brought together. The smaller extremities of a muscle that end in a tendon are termed origin and insertion, as they are fixed either to stationary or movable bone respectively. Locomotion is accomplished by various combined actions of many distinct muscles, placed together in the limbs.

The Naming of Muscles is usually from their shape, function, or position. Those we have to deal with are classed—

Abductors —	muscles that	draw from.
Adductors —	„	draw to.
Flexors —	„	bend limbs.
Extensors —	„	straighten limbs.

Groups in the Legs.—In the legs there are groups of muscles that are opposed to each other in their action, and it is the balancing of these actions upon the foot that enable standing and walking to be performed. In infancy, these muscles not being under control, the movements are undecided, and it is only after long practice that the combination of muscular movement is attained. The muscles in the leg are large and strong, and transmit power to the foot by means of tendons. These tendons do not change in form, *i.e.* stretch, and when in a state of tension they may be often seen beneath the skin. The muscles in the foot are smaller than those in the leg, and their action is direct, consequently they are graceful in their functions. The muscles of the leg perform the more powerful movements of the foot, while those situated in the foot itself give the more delicate and graceful motions.

Muscles of the Leg.

A. The anterior group (Fig. 15); B. The peroneal group (Figs. 16 and 17); and C. The posterior group (Fig. 18).

A. The Anterior Group.

1. Tibialis anticus.
2. Extensor proprius pollicis.
3. Extensor longus digitorum.
4. Peroneus tertius.

B. The Peroneal Group.

5. Peroneus longus.
6. Peroneus brevis.

C. The Posterior Group.

7. Gastro-cnemius, *2* (inside and outside).
8. Plantaris.
9. Soleus.
10. Tibialis posticus.
11. Flexor longus digitorum.
12. Flexor proprius pollicis.

1. **The Tibialis anticus** is a flexor muscle. It arises from the outside of the tibia and front of fibula, and descends inwards, where it is replaced by a tendon which inclines to the inner side, passing beneath the annular ligament, and is inserted in the first cuneiform and first metatarsal. Its action is to draw the upper surface of the foot towards the front of the leg; it also turns the great toe *inwards*, and raises the inside border. During contraction it is seen externally, marking in front of the ankle a clearly defined cord (Fig. 19).

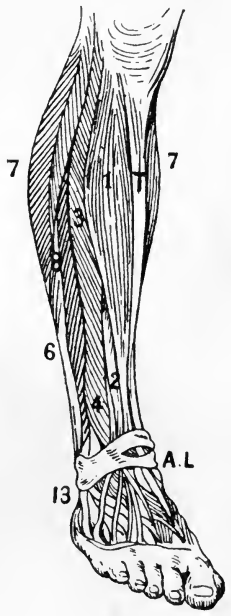


FIG. 15.

2. **The Extensor proprius pollicis** arises from under the *Tibialis anticus* (1) and descends (passing on the outer side of the tendon of the *Tibialis anticus*, beneath the annular ligament) along the upper surface of the foot, and is inserted in the base of the second phalanx of the great toe. Its action is to raise the great toe. It has a strong tendon that may be seen when the foot is extended and the toe is forced up (Fig. 20).

3. **The Extensor longus digitorum** arises from the outside of the tibia, and lies to the outer side of the *Tibialis anticus* (1). It descends by a tendon that divides but

remains together, and passes beneath the annular ligament. After it has passed the annular ligament, the divided tendon separates and spreads out. The four divisions are inserted into the last phalanx of the toes (Fig. 21). Its action, in conjunction with the *Tibialis anticus* (1), is to flex the foot on the leg, and also to extend the toes on the foot. During action it is visible on the upper surface of the foot.

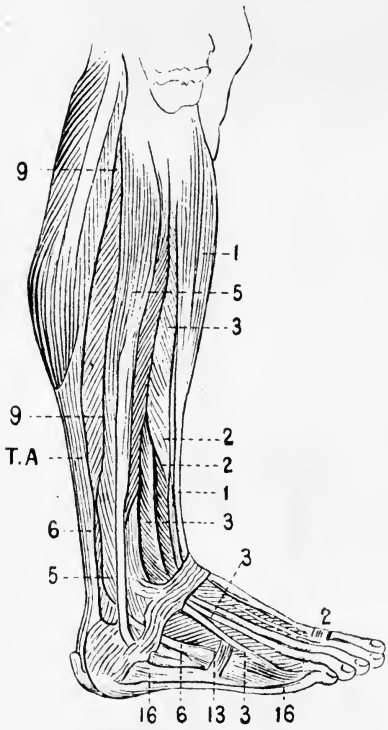


FIG. 16.

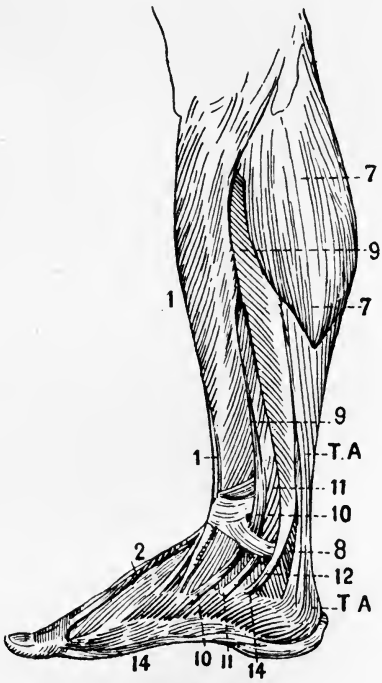


FIG. 17.

4. **The Peroneus tertius** is sometimes classed as the fifth tendon of the *Extensor longus digitorum* (3), with which tendon it goes beneath the annular ligament to be inserted in the fifth metatarsal. Its action is to raise the outer border of the foot.

5. **The Peroneus longus** arises from the head of the fibula,

and runs behind the outer ankle along the heel-bone, through the groove in the cuboid bone, across the sole of the foot, and is inserted in the first metatarsal. Its action is similar to that of the *Peroneus brevis* (6), and also serves as a bow across the arch increasing the hollow. It is brought into play during dancing.

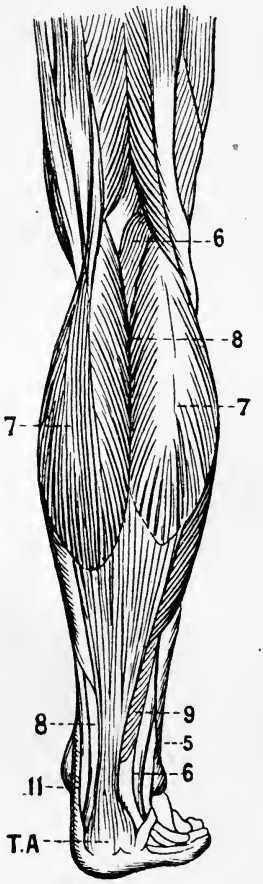


FIG. 18.

6. **The Peroneus brevis** arises underneath the previous muscle, and unites its tendon with the *Peroneus longus* (5). They together pass on the outside ankle along the heel, and the tendons (*Peroneus longus* and *brevis*) separate, and are inserted in the base of the fifth metatarsal. The action is to extend the foot and raise the outer border, turning the toe outwards. It is the reverse of the *Tibialis anticus* (1). These muscles are developed in those who walk, run, and dance, and with others give the largely developed calves that are observable in athletes.

7. **The Gastro-cnemius.**—There are two muscles bearing this name, one situated on the outside, and the other on the inside of the leg. Their origin is from the femur, and they are connected with the *tendon Achilles.* The action is to extend the foot on the leg, and by the tendon to raise the heel of the foot.

8. **The Plantaris** rises on the outside of the femur. It is a very short muscle united with the outside *Gastro-cnemius* (7). It is situated between the *Gastro-cnemii* (7), and gives place to a long thin tendon that sometimes unites with the *tendon*

Achilles and sometimes with the fatty tissue of the os calcis.

9. **The Soleus** muscle is placed beneath the *Gastro-*

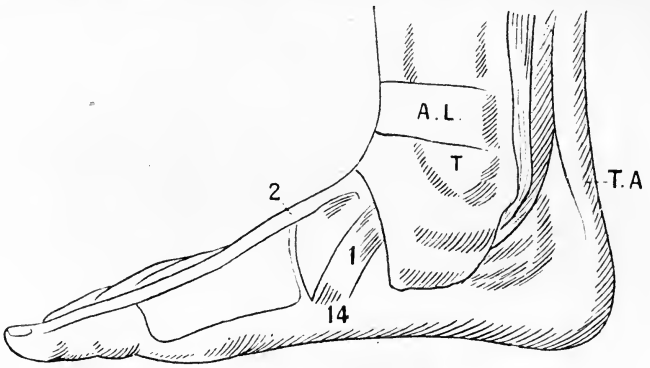


FIG. 19.

cnemii (7). It arises from the tibia and fibula, and combines with the *Gastro-cnemii* (7) to form the *tendon Achilles*, that is the strongest tendon in the body. The tendon is very tough and cord-like, and does not change in bulk.

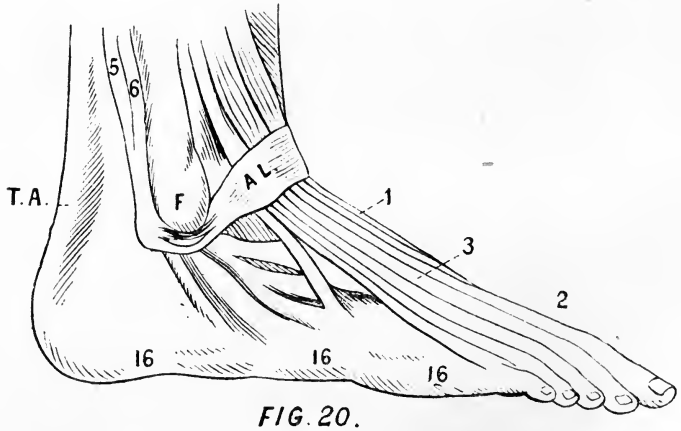


FIG. 20.

It is affixed to the os calcis, and is the means afforded to raise the heel and depress the toes.

10. **The Tibialis posticus** arises, from the tibia and fibula,

and descends, by means of a tendon, behind the inside ankle, and is inserted in the scaphoid. Its action is to bend and turn the foot inwards.

11. **The Flexor longus digitorum** runs at the back of the inner ankle from the tibia. In the sole it divides into four branches that are inserted in the toes. Its action is to bend the toes and to cause them to grip in walking.

12. **The Flexor longus pollicis** has origin in the fibula, and passes through the groove at the outer side of the astragalus to the great toe. Its action is to raise the body on the end of the great toe, to press the ball of the toe to the ground, and thereby to raise the outer ankle.

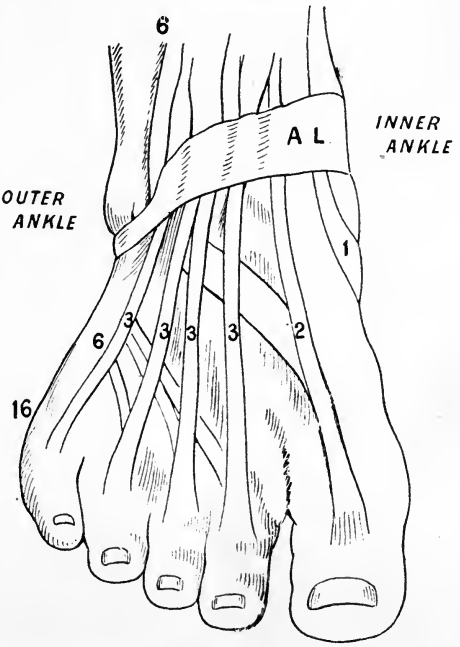


FIG. 21.

It must be understood that when the muscle is spoken of as passing under the annular ligament, or round the ankle, the tendon which transmits the muscular force is meant. It is thus described for brevity.

The Muscles of the Foot.—The foot owes its peculiarities of form to its bony structure; the muscles round off the angular structure. They are usually but little developed, and, being situated in masses, it is difficult to isolate and describe distinctly the precise action of the individual muscles, so that a brief description of the several muscles

will serve our purpose. There are four layers of muscles in the sole of the foot, and two on the upper part of the bones. After the skin of the plantar region and the fatty tissue has been removed, an expansion of fibrous tissue known as the plantar fascia is visible. If this be taken away the first layer of muscles is exposed, consisting of *Abductor pollicis* (14), *Flexor brevis digitorum* (18), and the *Abductor minimi digiti* (16) (Fig. 22). The second layer, situated under the first, consists of the tendons of the *Flexors longus digitorum* (11) and *Proprius pollicis* (12). On the outer side of the foot, the tendon of the *Peroneus longus* (5) passes beneath the *Flexor accessorius* (20). To complete the layer the muscles *Flexor accessorius* (20) and the lumbricales (19) must be named (Fig. 23). The third plantar layer consists of the tendon of *Tibialis posticus* (10), the *Flexor brevis pollicis* (15), the *Adductor pollicis* (21), the *Flexor brevis minimi digiti* (17), and, running across the foot, the *Transversus pedis* (22). The sheath of the *Peroneus longus* (5), and

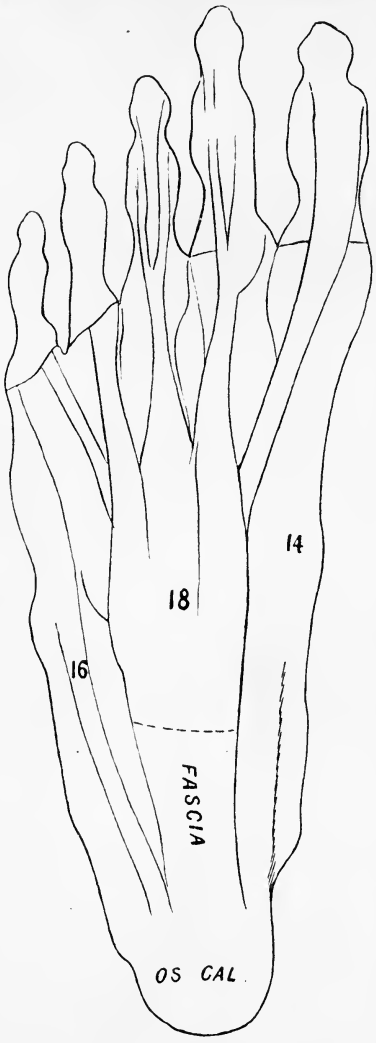


FIG. 22.

the *plantar ligament*, are also found in this layer (Fig. 24). The fourth layer (Fig. 27), consists of three *inter-ossei* (23),

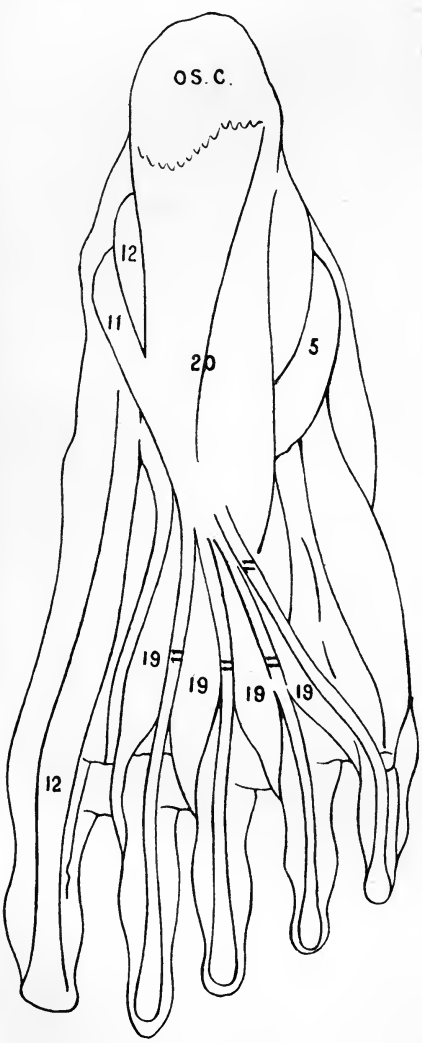


FIG. 23.

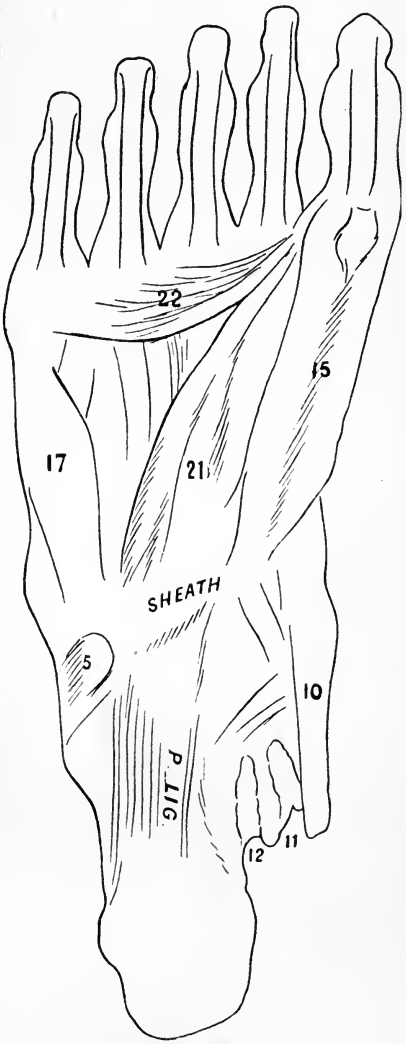


FIG. 24.

one on the inner side of the second toe, and the others one each on the inner side of the third and fourth toes.

They draw to the central line XY, which in this treatise will be called the "central muscular action line," or the "line of muscular action." The first layer (Fig. 26) on the dorsal surface consists of the tendons of the *Tibialis anticus* (1), *Extensor proprius pollicis* (2), *Extensor longus digitorum* (3), and the *Tertius peroneus* (4). The muscles of the *Extensor brevis digitorum* (13), after passing under the *Extensor longus digitorum* (3), divide into four tendons, and aid in the extension of the toes. The second layer (Fig. 25) consists of four *inter-ossei* (23A), fixed on the outer side of the second, third, and fourth toes, and draw from the "central muscular action line" XY, and one on inner side of second toe drawing to line XY.

MUSCLES OF THE FOOT.

A. Dorsal; B. Plantar (internal, external, central).

A. Dorsal Group.

13. Extensor brevis digitorum. First layer.
23A. Inter-ossei dorsal (*4*). Second layer.

B. Plantar Group.

14. Abductor pollicis.	Internal first layer.
15. Flexor brevis pollicis.	Internal third layer.
16. Abductor minimi digiti.	External first layer.
17. Flexor brevis minimi digiti.	External third layer.
18. Flexor brevis digitorum.	Central first layer.
19. Lumbricales.	Central second layer.
20. Flexor accessorius.	Central second layer.
21. Adductor pollicis.	Central third layer.
22. Transversus pedis.	Central third layer.
23. Inter-ossei plantar (*3*).	Fourth layer.

13. **The Extensor brevis digitorum** arises in the upper outer side of the heel-bone, and, broadening out, it passes under the *Extensor longus digitorum*, when it divides into four tendons that go forward and are inserted in the bases

of the first phalanges. Its action is to aid the extension of the toes and to counteract the tendency of obliquity of the *Extensor longus digitorum.*

14. **The Abductor pollicis** rises on the inner posterior region of the os calcis, and is inserted in the first phalanx of the great toe. Its action is to abduct the big toe away

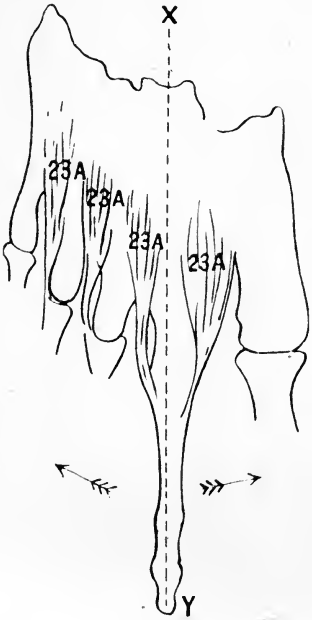


FIG. 25.

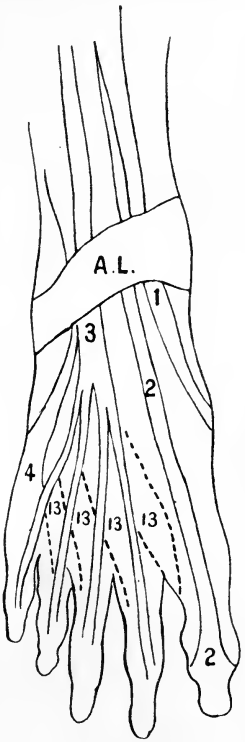
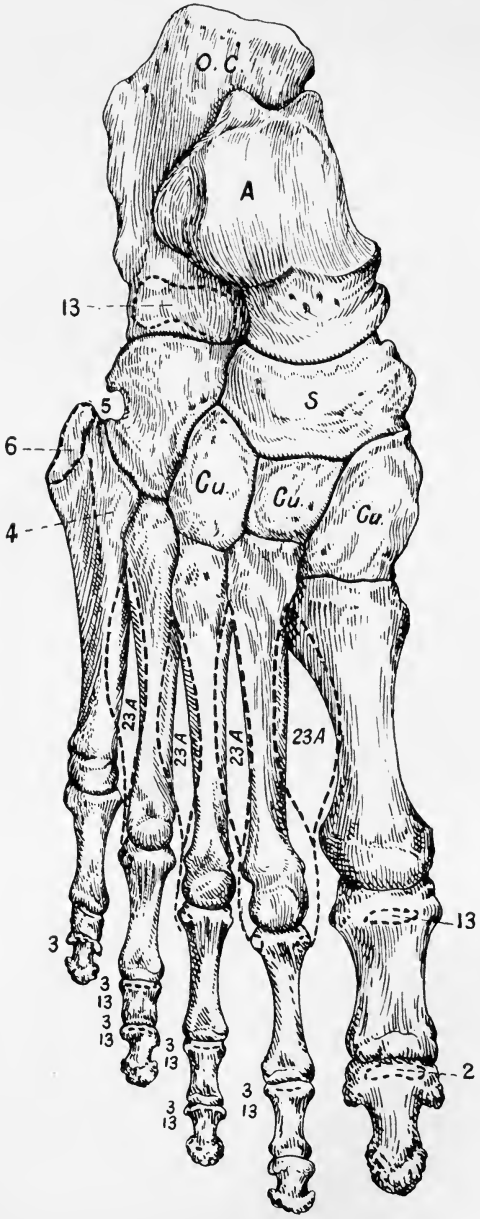


FIG. 26.

from the central line of the foot to the imaginary line that forms the centre of the body. By this action the great toes would be brought closer together.

15. **The Flexor brevis pollicis** comes from the second row of the tarsus, and is inserted to the base of the first phalanx.

16. **The Abductor minimi digiti** arises from the outside



DORSAL VIEW

of the os calcis, and goes forwards to the external side of the first phalanx of the little toe. Its action is to draw the little toe away from the middle line of the foot.

17. **The Flexor brevis minimi digiti** has origin in the sheath of the *Peroneus longus* and the base of the fifth metatarsal bone, and is inserted in the first phalanx of the little toe. Its action is to flex the little toe.

18. **The Flexor brevis digitorum,** from the heel-bone and the plantar fascia, draws down the toes, and is inserted in the second phalanges of the four toes.

19. **The Four Lumbricales** are affixed to the inner side of the four toes. Their action is to draw the toes in to the inner side of the foot.

20. **The Flexor accessorius** extends from the os calcis to the second, third, and fourth toes. In contraction it counteracts the obliquity of the *Flexor longus digitorum,* hence its name.

21. **The Adductor pollicis** arises from the sheath of the *Peroneus longus* and the third and fourth metatarsals, and is inserted in the first phalanx of the great toe on the outer side. Its action is to adduct, or draw, the great toe to the central line of the foot.

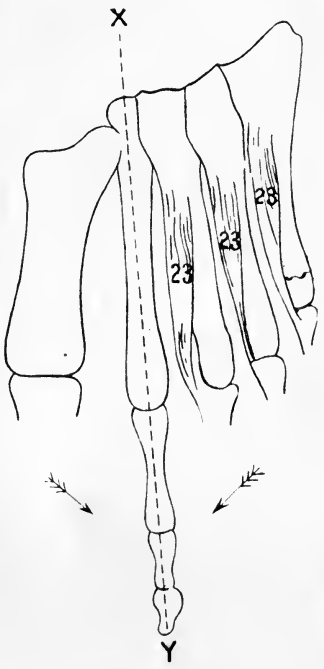


FIG. 27.

22. **The Transversus pedis** goes across the foot, and is inserted in the phalanx of the great toe. Its office is to adduct, or draw, the big toe to the line of the foot termed the "line of muscular action."

23. **The Three Plantar inter-ossei** are situated between

the bones of the toes on the inner side, and draw to the central line the three outer toes.

23A. **The Four Inter-ossei**, on the dorsal surface of the foot, are situated on the outer side of the bones of the toes, and draw the third and fourth toes away from the central line of muscular action. The two *inter-ossei* on either side of the second toe draw away from the axis of the toe either to the outer or inner side of the foot respectively.

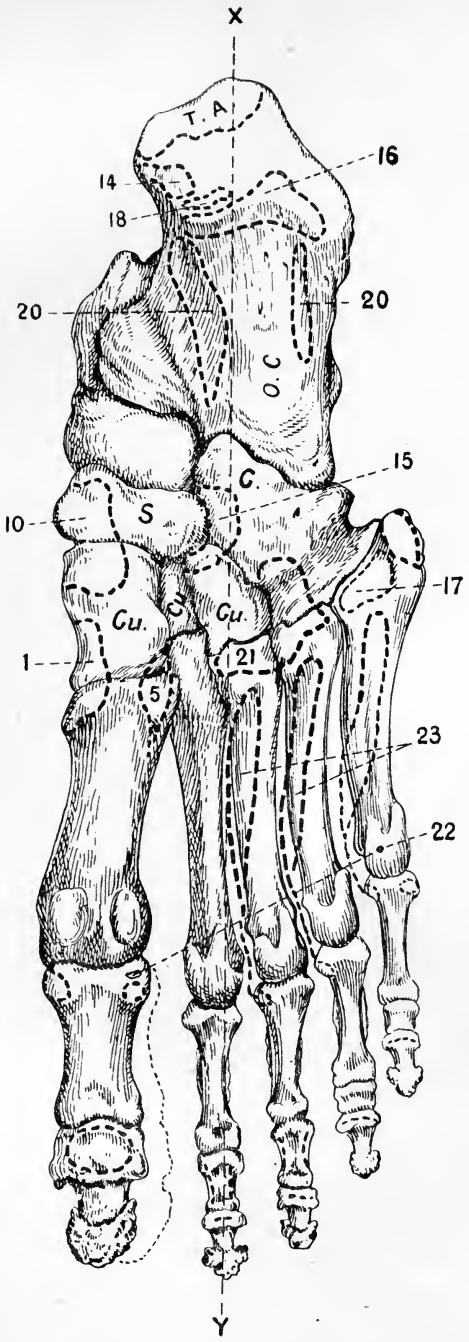
Nerves.—The foot is provided with two kinds of nerves —those that supply the skin with sensory branches, and the other sort that give motor impressions to the muscles. The *posterior tibial* and the *anterior tibial* nerves come from the *sciatic* nerve, the former giving branches to the muscles in passing down to the inner side of the ankle. The *posterior tibial* then divides into *external plantar* nerves and *internal plantar* nerves, that supply the toes and sole of the foot. The *anterior tibial* nerves supply the dorsum of the foot as well as the outer side of the leg.

Arteries, etc.—The chief arteries of the foot are those situated on the dorsal and plantar surfaces. The plantar consists of two—inside and outside. The veins of the foot are of two kinds—surface and deep. They follow the direction of the arteries.

The Skin consists of two layers—the epidermis and dermis; the dermis, or true skin, is made of fibrous tissue, interposed with blood-vessels and nerves. The skin on the sole of the foot possesses no sebaceous glands that keep the skin oily and soft. Sweat glands are, however, numerous. Under the skin are found pads of fat, at the heel and toes especially.

When **standing**, the weight of the body is transferred to both pillars of the arch; the inner side of the arch sinks a little, and the outer side nearly touches the ground. The foot thus forms a firm basis of support, becoming slightly longer and wider.

Walking is performed as follows: (1) by lifting one leg from the ground and bending the knee, which throws



PLANTAR VIEW

the weight on one foot; (2) by raising the other leg on the ball of the great toe and bending the body forward, throwing the weight on to the leg first extended. During the action of walking one foot or the other is always on the ground (Fig. 28).

FIG. 28. WALKING

Running is a kind of very quick walking, only, both feet for short periods are from the ground together.

The Mechanics of the Foot.—The active agents in the mechanism of the foot are the muscles, and the passive the bones, ligaments, joints, etc. The bones are the levers, and the muscles the power. Levers are of three kinds, the classification being determined by the relative positions of the power, the fulcrum, or central pivot, and the weight moved.

1. The power—the force that performs the work of lifting or moving, *i.e.* the muscles.

2. The weight—the resistance offered or weight lifted by the power.

3. The fulcrum—or centre point of the movement of the lever.

There are three orders of levers, the first order being when the fulcrum is in the centre of the lever, the weight and power on either side (X, Fig. 29). A see-saw is a good illustration. The second order is when the fulcrum is at one end of the lever, the weight in the centre, and the power at the other end (Y, Fig. 29). A wheelbarrow illustrates this class — the wheel being the fulcrum, the load carried the weight, and

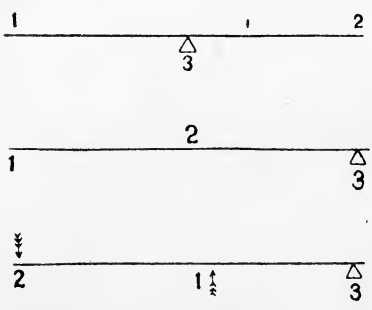


FIG. 29.

the person wheeling the power. The third order is when the fulcrum is at one end, the weight at the other bearing downwards, and the power in the centre in an upward direction (Z, Fig. 29). A man raising a ladder to a wall illustrates this form of lever.

The foot is said to be a lever of the first order when the toes are pressed to the ground (weight), the heel raised by the power from the *tendon Achilles* (power), and the ankle joint the movable fulcrum; or, if the toes are off the ground, in the act of raising a ball, it could be classed under a lever of the first order (Fig. 30).

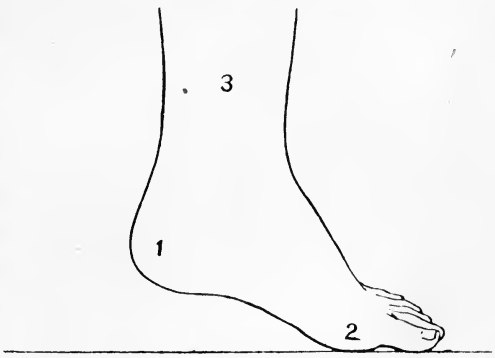


FIG. 30.

The foot is classified as a lever of the second order when the toes are on the ground as a fulcrum, the weight being that of the body transmitted *viâ* the tibia, and the power the muscles of the calf operating through the *tendon Achilles* (Fig. 31).

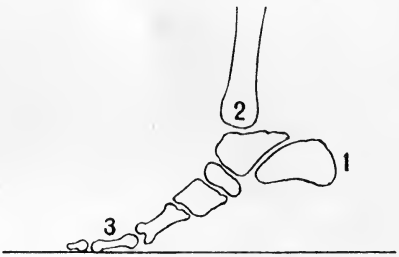


FIG. 31.

The third order is exampled when the heel is placed on the ground, forming the fulcrum, the toes are raised, being the weight, and the muscles of the front of the leg the power (Fig. 32).

The understanding of the mechanism of the foot is not simple, due to the complexity of the joints, the twists and curves of the bones, the transmitted and direct action of

the various muscles, and the obliquity of the joints. It is not surprising, therefore, that many opinions are formed respecting the various movements. The difficulty of precisely stating the effects upon the contour and size of the parts of the foot, is the cause of varying theories as to the best form of shoe, advocates of a particular form usually considering the foot in one series of motions only.

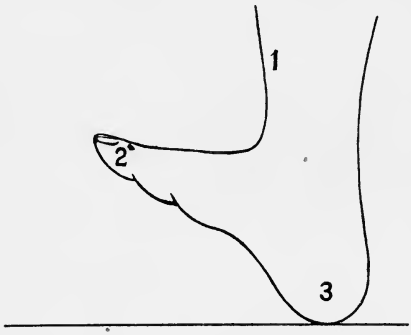


FIG. 32.

Applicable Observations, of practical value in clothing the foot, will be made that will impress the value of the study of the structure of the foot.

The non-symmetrical appearance of the *foot* should be especially noted—the inner edge being practically straight, and the outer one curved. The two sides of the foot are different in construction and function, but the foot is a complement and counterpart of its fellow. When the foot is in a position of rest, the edge of the inner side is hardly straight, but when in activity, it is somewhat concave. Lasts should not be "straights," but rights and lefts. The functions of the toes should be remembered in making or selecting lasts. The great toe, when suddenly called into action, moves outwards, and forms a solid base to propel the body onwards. There are only two phalanges in this toe, giving the impression of strength. This toe is thicker than the others, so that the last should be thicker on the inside. When the heel is raised the great toe moves inwards, as seen by the dotted line in the plantar view (p. 29). By constructing shoes that compel the toe to remain in this position, the space at the end of the phalanx is filled by a growth of bone, etc., and bunions are formed. The smaller toes are flexed when in action, and the joints of the toes

present a series of uplifted prominences while gripping the ground. The preservation of these functions should be the consideration of the producer of boots and shoes.

The muscles in exercise promote growth, and when properly developed, they are taut when not actively employed, thereby keeping the bones in place: pressure prevents the development of muscular activity, and the partially formed muscles do not brace up the bones, hence the joints sink. The joint-action of the opposing muscles should be considered, with their variety of movements and alteration in shape.

Free play to the joints is a necessity to the fullest usage of the foot. The "ankle-bone" prominences vary in position on opposite sides of the foot; the outer bone being lower down and further back than the inner. This has an important bearing on the making of shoes. The arches of the foot serve the purpose of affording protection from pressure to the muscles, vessels, and nerves; and the provision for elongation when weighted, must not be overlooked in foot-gear. The transverse arch is not equal at both sides of the foot, the inner side being higher than the outside, and lasts that are equally arched on both sides do not conform to the requirements of the foot (compare Figs. 12 and 13). Fastenings to shoes should not tighten across the instep, but the strain should preferably be from instep to heel. The skin in the arch or waist of the foot is thinner than at the balls of the toes and the heel, giving greater elasticity to the waist, and the thicker skin where pressure is experienced gives protection to the parts that come into contact with the ground. The sole is richly provided with nerves, and projections of badly laid socks, rivets, or other irregularities in the inside of shoes are the cause of much pain to the wearer. The effects of placing heels on boots are many. Some of them are: the prevention of the lowering of the heel of foot to gain the impetus so necessary to exercise the muscles that give the force to spring to tip-toe; the resting of the foot on an incline plane,

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and thereby giving it a tendency to go forward towards the toe of the boot; and the production of a more convex instep and the appearance of a shorter foot. It is also supposed to tilt the posterior pillar of the arch of the foot, thus dislocating the bones that give its characteristic; but this should not occur if the heel be placed well under the centre of gravity of the weight transmitted, and the muscles are not otherwise prevented from attaining their proper development. The higher the heel adopted to raise the heel of the foot, the shorter will be length measured as on a size-stick, although the same cannot be said of the actual length of the foot.

To conclude this chapter it is essential to note that exercise increases the circulation of the blood, and that owing to the tendency of the inner sides of the foot to go together (see Fig. 14), the fullest play should be given for the functions of the foot to perform their work, and that any interference with the structure makes it less effective. Cramping the leg and foot with stiff uppers causes the deterioration of the muscles and prevents their proper action. A healthy shoe should give the movements of the foot their action, and should conform to the requirements that are most general, and it should also be borne in mind that alteration in shape takes place during muscular movements, and that foot-gear should vary as the motions of the foot are impeded or increased.

CHAPTER II.

CHARACTERISTICS, CONTOURS, TYPES OF FEET, ETC.

Variety in Feet.—Structurally all feet are alike, but in form and measurement there exists great diversity. From three fundamental types of man, there are some seventy-two distinct races, each race having its characteristics. Even in a single race there are an infinite number of variations of the external form of the body. And so it is with feet; they differ in detail, and it is quite the rule to find a difference between the two feet of a single individual. Feet, however, may be classed, and their salient points of resemblance and difference compared and contrasted. This may be done in many ways—by tabulating the ratio the various parts of the lower extremities bear to the whole stature; by comparing the profile of various feet; by the plantar outline; and by measurement. All of these methods are useful in their way, and helpful in giving a better knowledge of the foot to be clothed.

Average Proportions.—At birth the average height is 19·3 in. male, and 18·9 in. female. The average mature statures are 5 ft 9 in. male, and 5 ft. 5 in. female. If the total stature be represented by 67, then the various parts are relatively proportioned—

	Male.	Female.
Femur	18	18
Tibia	14	14
Foot from lower edge of tibia to end of second toe ...	9	8

The proportion of the various segments of the lower

extremities may be given to the total height in a percentage basis, and for the male sex would be—

Thigh (seat to knee)	...	...	20 per cent.	of the height.
Leg (knee to ankle)	...	..	23 „	„
Ankle to ground	...	...	4½ „	„
Foot	...	...	15 „	„

The proportions in the infant are different from those it has when it arrives at the adult period; between these two epochs the proportions are constantly altering. The relations in this matter between the two sexes in childhood are nearly the same, and at a certain age—puberty—they commence to take on the characteristics of the adult. The lower extremities, measured from the sole of the foot, double their length before the person reaches three years of age; and at the age of twelve they have increased four times, and at twenty about five times, their original length. The various parts do not increase at the same rate—those situated near the trunk increase at a greater rate than those more distant; for instance, the leg during its growth increases four and a half times, the height of the foot from the ground three and a quarter times, and the length three and a half times, over what it was at infancy. In growing, the thighs develop first, next the upper part of the legs, and lastly the feet.

Characteristics at Different Periods.—In infancy the foot is broad at the toes, the line of the inner margin of the feet going outwards from the middle line of the foot. The toes lie forward in the direction of their length, and the heel is small in comparison to the width of the toes. They are also short in length, due to the undeveloped metatarsal bones. During growth, the apparent thickness above the heel-bones disappears, and as the metatarsals progress the foot is more proportionate. The heel becomes thicker, and the tarsal bones develop during the succeeding stages of growth, and if the foot has been well exercised and properly cared for, it reaches its beauty of perfection at maturity, and can be classed in its appropriate type.

The Adult Foot, it should be noted, when properly formed, is straight from heel to toe on the inner side, and is wider across the joints than one inch or so further back. The line *ab* in Fig. 33 is not so wide as *cd,* and this must be provided for in lasts. It is not usually done in English-made goods, hence the unsightly wrinkles at the "feather," near the inside joint in a large number of boots and shoes. If the shoe is made to fit at *ab,* and other things are right, it will prevent the foot from going too forward in the shoe, and compressing the toes. When the instep of a foot is high, the heel of the foot is usually short, and the ankle thicker.

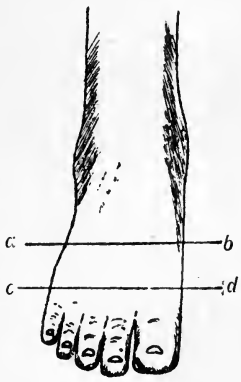

FIG. 33.

The well-developed calf, a well-arched foot, and a graceful step are generally present in the same foot. The projection of the heel-bone, and the variations in ankles, are dependent upon the position of the leg in relation to the foot from an imaginary vertical line at the back of the leg. When a joint is small in girth, the instep and ankle are usually greater in proportion to the joint-girth. A foot that is narrow in *sole* area may be thick or full above, and, on the other hand, a foot may be slim and measure less in circumference and have a spreading sole-area; so there is a difference between a *narrow* and a *slim* foot. The arch of the waist of a foot varies considerably in different feet, and feet that measure the same in girth have a differently shaped arch. A person's occupation will cause a difference in the development of the feet.

The Mode of Walking has a considerable bearing on the character, contour, and development of the foot. There are many opinions as to the correct way of walking and standing. Boots that may be correct to *stand* in may not be correct to *walk* in. The walk of a person has an important bearing on the shape of the boot required, and

some of the sole shapes that have been advocated by medical men do not prove in practice to be the best adapted for walking.

Camper's Theory * was that the toes are naturally parallel to the line drawn through the centre of the sole and heel, and that the second toe is longer than the others. The sole should be as broad as possible, and the end of the toe should be raised, to prevent coming into contact with stones. The heel should be moderate in height, and placed well under the foot, to sustain the centre of gravity of the body. The toes should turn out in walking or standing.

Meyer's Theory † was that all feet are alike in mechanical construction, and that the only differences in healthy feet are those arising from varying length and breadth. A line drawn from the middle of the heel—on the sole—under

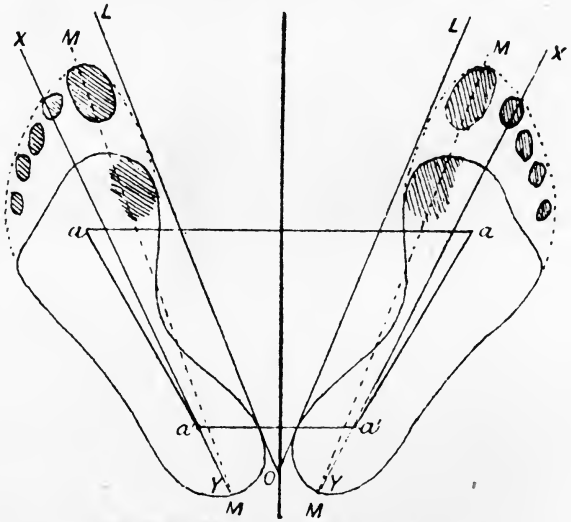

FIG 34 MILITARY POSITION OF STANDING

the centre of the ball, or joint, should pass under the middle of the great toe through its whole length. This

* "On the Best Form of Shoe," by Dr. Camper.

† "Why the Shoe Pinches," by H. Meyer, M.D.

line is usually termed "Meyer's line," and is shown in the illustrations in this book as "MM."

The Military Position of standing is to turn the foot outwards, so that the inside margins of the two feet are at an angle of 45°. It is not the strongest method of standing, and this is explained by the fact that, when the foot is turned outwards, the great toe turns up, and the muscles that straighten the toe and keep it in the line of its length are rendered less effectual when operating on an elevated toe, hence the foot is not in its position of greatest security. In the illustration of this method of standing (Fig. 34), the figure *aaa'a'* will show that, when the person is pushed from the front, the base at the back (*a'a'*) is insufficient to give a firm support of resistance.

The Four-square Position of standing is the most secure. A line drawn longitudinally through the centres of the

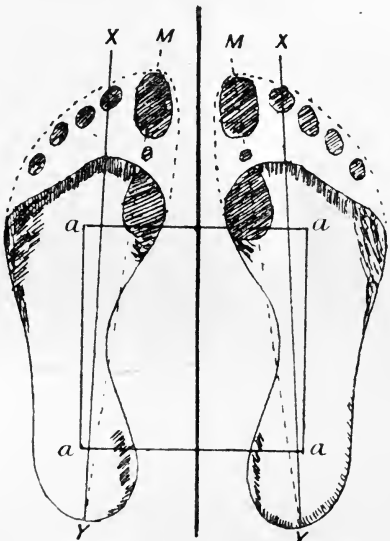

FIG 35 FOUR-SQUARE POSITION OF STANDING

tread and the heel of each foot will be parallel. The inner edge of the foot in this method of standing will make an

angle of 10° with the central line of the body, or 20° with the other edge of the foot. When standing four-square the arch is most firm, the muscles are in a position to act as "rods," and the base of support afforded by the two feet is the greatest (see *aaaa*, Fig. 35).

The Footfalls when walking vary at different periods of life, and also in the two sexes. A rather difficult method of placing the feet on the ground when walking is shown in Fig. 35, but it would give free action to the functions of the foot if it could be adopted. The military style of walking is one that is very tiring, and not calculated to develop the powers of the foot (Fig. 34). Another

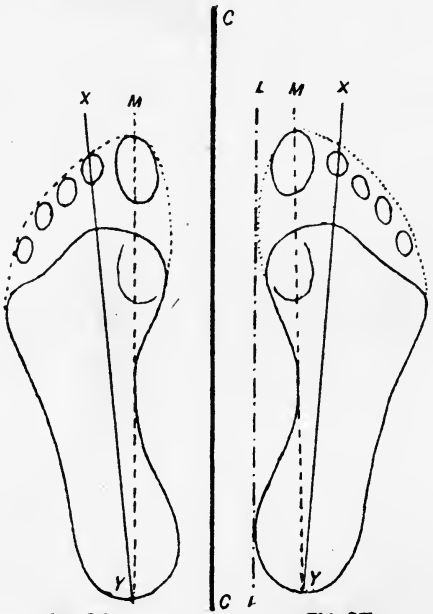

FIG 36 FIG 37

mode of placing the foot to the ground is illustrated in Fig. 36, where "Meyer's line," M, is parallel to the central line of the body, or the direction taken in progression, CC. It would be an easy way to walk, if the foot-gear allowed the free play of the big toe, and the heels of the shoe

were exceedingly low. If the inner edges of the feet are made parallel to the line of direction, another variation in walking is exhibited, as seen in Fig. 37, where the line LL is parallel to the central line CC. The most practical

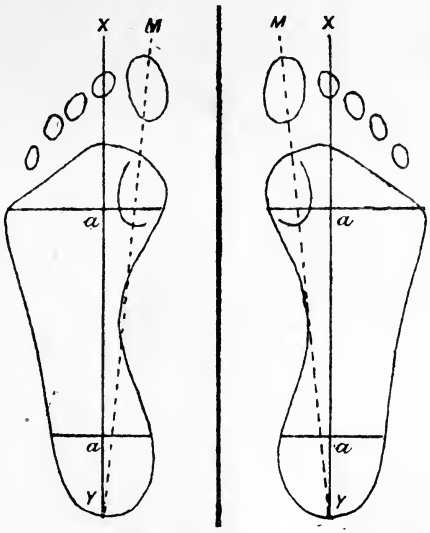

FIG 38.—HOW THE FEET SHOULD FALL IN WALKING.

method of allowing the foot to fall on the ground is shown in Fig. 38, where the "lines of muscular action" are shown parallel to each other and to the direction of walking. This allows a four-square basis of support to be maintained (*aaaa*), and the muscles on either side of the foot abduct from and adduct to this line, while full advantage of the buttress projections of the outside joints is taken; further, it accords with shapes of soles that have been found in practice to be most effectual to preserve the functions of the foot. This "line of muscular action," XY, is the best middle line to adopt in designing sole shapes.

The shortness of the legs in children, and the width of the hips in women, make their walk different to that of the male sex.

Types of Feet.—The many sorts of feet that are met with are due to a number of causes, such as habits, climate, occupation, locality, etc., and it is the combination of these

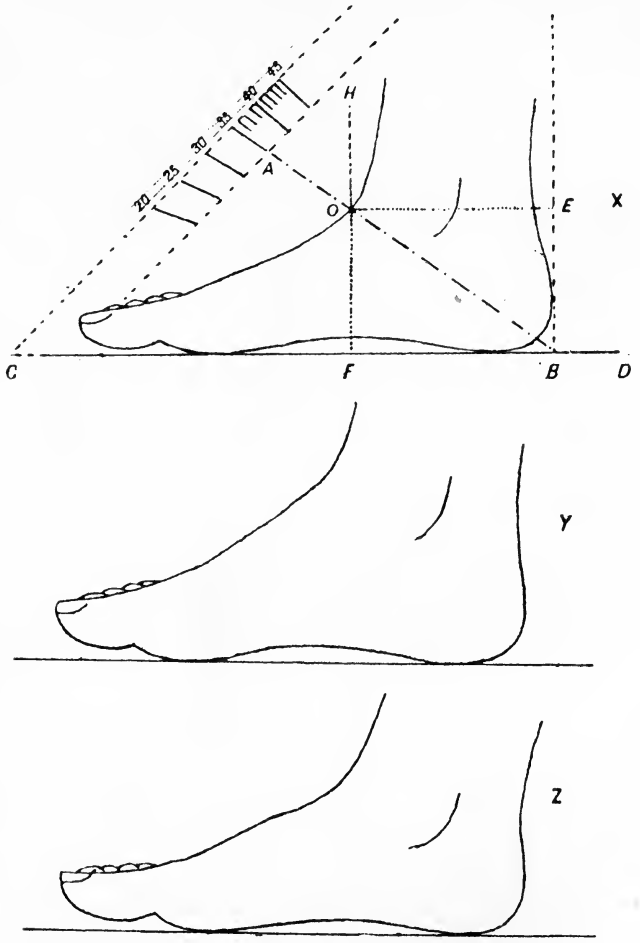

FIG. 39.

in different degrees that give so many distinctions in profile, sole-area, and disposition of measurement (see Figs. 39, 40, 41, and 42).

As a general rule, the foot has characteristics in common with the body to which it is connected. A person with a form of moderate plumpness, a fondness of exercise and activity, and a good circulation, possesses feet that are well developed and symmetrical. The heel is round and

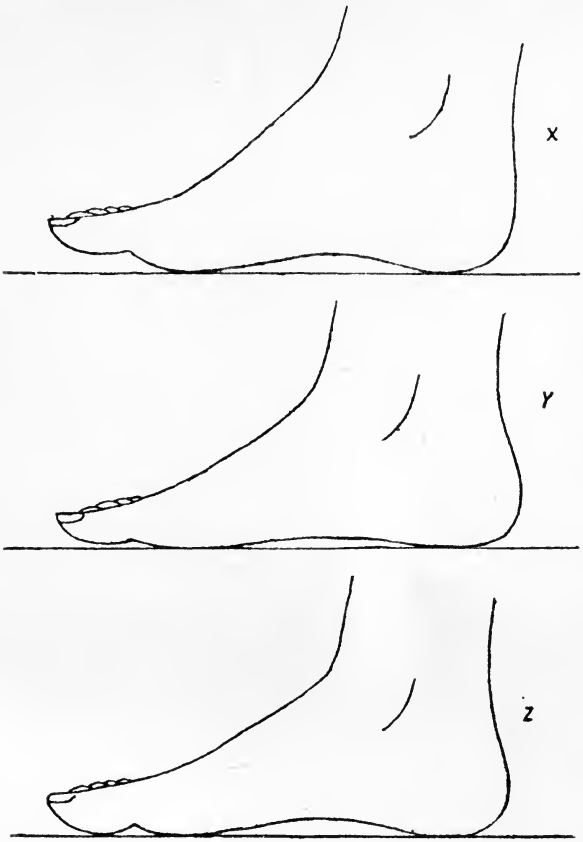

FIG 40.

fairly prominent, and the arch of the waist is duly developed, although there are no special bony prominences. On the other hand, a person with a body of general roundness, but with soft tissues and muscles, flabby flesh, a languid blood circulation, and dilatory in action, has feet

that are short, full in fitting, soft and flabby flesh, with a slight arch. Another variety of person has a strong bony frame, with strong firm muscles, prominent bones and features, and flesh that is hard and firm. The feet of this type of person are usually long, bony, arched, with a well-developed big toe joint, the heel-measurement large in proportion, and the instep-girth not large in relation to the other portions of the foot. It is a foot that is prevalent among the Scotch. The feet of the person who is delicately shaped, with a small frame and thin small tapering muscles, are usually thin and finely shaped, giving evidence of sprightliness. This form of foot, if found with a weakly constitution, is liable to a tendency to flat foot, which if neglected becomes very painful.

Classification according to Temperaments.—There are three primary forms of temperament—motive, vital, and mental—these names being applied according to the predominant characteristics of physical constitution, vitality, or mentality respectively.

The *motive* is the result of climate and habits, and is prevalent among mountaineers. In the Scotch and Swiss it is strongly marked. Its characteristics are large bones, hard muscles that are developed, prominent joints, and an angular figure of more than average height. The feet are long and bony, with large toe joints; the heel-measurement is large, and the joints and instep are nearly the same in girth. Boots for this class of foot must be made well up to measure, and be correctly shaped.

The *vital* stature is above medium, and has a greater breadth of body than the motive. The muscles and bones are not so conspicuous as in the motive, but the limbs are plump and tapering. It is the usual type of women, and the feet are small, symmetrical, and arched.

The *mental* type has a framework that is comparatively slight; the muscles are small and compact, designed rather for rapid action than strength. The structure is fine, and the feet are thin and nicely shaped.

Various combinations of the three types exist, and are usually classed by combining the two names that give a description of the prevailing qualities, the first name used

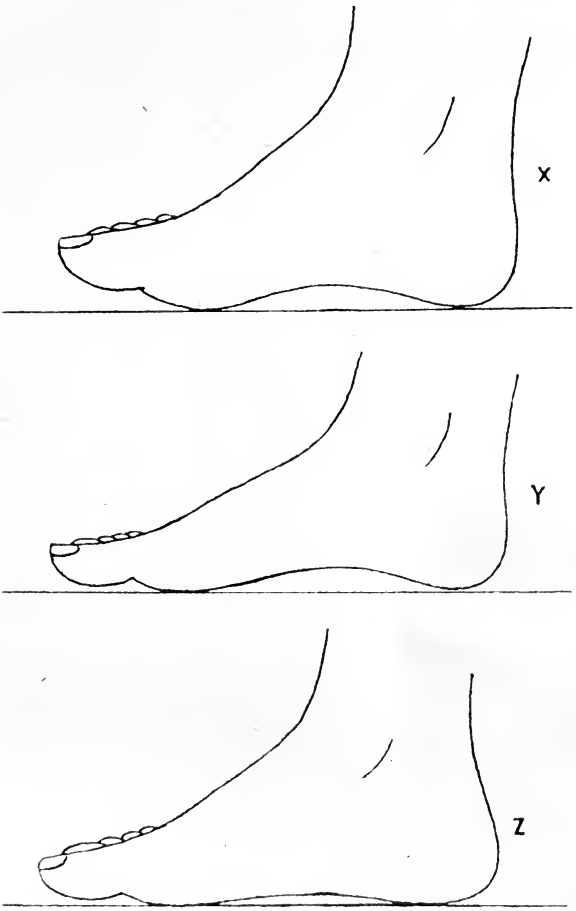

FIG. 41

denoting the greater development. They are motive-vital, motive-mental; vital-motive, vital-mental; mental-motive, mental-vital. The second of these combinations are largely found among the Americans, Scotch, North Irish, Welsh,

and North Germans. The mental-motive is found in large cities, and the foot is long, thin, rather flat, and narrow in fitting.

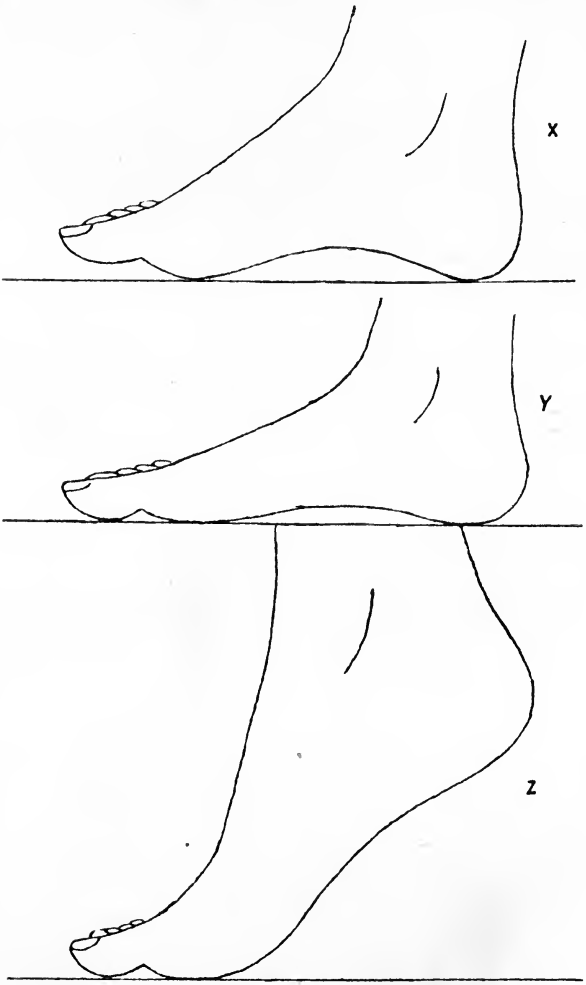

FIG. 42.

The Feet usually met with may be arranged as under:—

1. *Slim.*—A smart symmetrically shaped foot, with

arched instep, small joints, short heel, and thin ankle. The difference in measurement between the joints and instep in women's would be about $\frac{7}{9}$ in., and in men's $\frac{8}{9}$ in.

2. *Long.*—A thin, long, narrow-jointed foot, with a narrow sole-area and prominent heel. The foot is thin transversely below the ankle, and the instep would be about $\frac{3}{9}$ in. greater than the joint-girth.

3. *Average.*—A plump, graceful foot, with an arched waist. It is round, and the instep is about $\frac{4}{9}$ in. larger in women's and $\frac{5}{9}$ in. in men's than the joint-girth.

4. *Full.*—A foot of great muscular development, prominent joints, thick, fleshy, and spreading. The difference between instep and joint is about $\frac{7}{9}$ in.

National Difference.—The feet of the Scotch are large, flat, and bony. They are somewhat broad toed. The Irish feet are short and chubby. The English have broad feet at the instep and joints, with an inclination to tapering toes. The French have long, high-arched feet, with slim toes. The Spaniard's feet are small with arched insteps, long tapering toes, and small heel-measurement. The German foot is chubby and arched.

Plaster Casts are used to study the various contours of feet, etc., and, to ensure proper deductions, they ought to be properly made, so as to give the relations of the parts and the leg to the foot. A cast may be taken in two ways. The foot to be taken is well greased, and any hairy growth well laid to the skin with the grease used. A mixture of tallow and oil is a good thing for this purpose. A large dish is convenient to use, and three pieces of cork of equal size are provided to place under the ball of the big toe, the outside joint, and the heel of the foot. This is to steady the foot while being cast, and the weight of the person should not be borne on the pieces of cork. A piece of string that has been previously greased is placed down the front of the leg over the instep to the toes. This may be done by using a small portion of paste every two or three inches to fasten the twine temporarily to the bends

of the leg and foot. The upper end of the string is brought over the knee and given to the person whose foot is being cast to hold; the other end is carefully laid, without undue tension, in a direct line across the dish. Another thread—greased—is passed under the waist of the foot and carried up both sides of the leg to the knee, and held with the other thread. A thread at the back of the foot is next laid, and the ends left so that they may be easily used to separate the plaster when nearly set. The last thread is placed round the foot, from the heel at back along each side of the edge of the foot. Superfine plaster of Paris is added to about a pint and a half of water until of a thick creamy consistency, and carefully placed under the foot, care being taken not to disturb the pasted strings. While the plaster is setting, it must be piled up round the foot, keeping it of even thickness without displacing the threads. When the plaster is nearly set, the threads are drawn carefully, so as to cut through it, making a divided mould. The mould is then removed from the foot and put together, ready for producing the cast. This is a quick method of taking a mould, and is sometimes useful to resort to when lasts have to be made to feet that are something out of proportion. A better method for taking a cast for experimental studies is to take it in stages in a properly constructed box.

Taking Mould in Sections.—The box is preferably made from hard wood and put together with screws. It consists of three separate portions—top, middle, and bottom; the inside measurement when put together being $5\frac{1}{2}'' \times 12'' \times 6''$. The bottom is made with a groove running round to snugly fit the middle, and on the four sides of the middle section are screwed four pieces of wood to hold the top firmly in position (see Fig. 43). The whole of the inside of the box should be as smooth as possible.

To take the Mould.—The box and foot are well greased and three pieces of greased cork, about an inch in thickness, are placed in position on the bottom to catch the heel and

tread of the foot that is to be taken (A, A, A, Fig. 43). The middle section is placed on the bottom, and the foot put in the position that it is desired to mould. If an

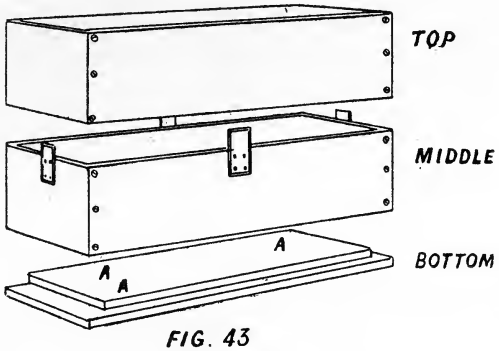

FIG. 43

upright pose is wanted the front of the leg should be vertical with the ground, and the weight may be relieved from pressing on the corks—thus spoiling the plantar impression—by allowing the person who is operated upon to be seated.

Mix the plaster to the thickness of cream, and pour into the box to the level of the edge of the foot. As it sets, build it well under the arch of the waist on the inside of the foot, rounding the top as smoothly as possible (Fig. 44). When the plaster has set — about ten or fifteen minutes— remove the foot and allow the section of the mould thus taken to harden. When this is accomplished, the whole of the surfaces that will come in contact with the wet plaster to be used in the next operation, together with the foot and the top section of the box,

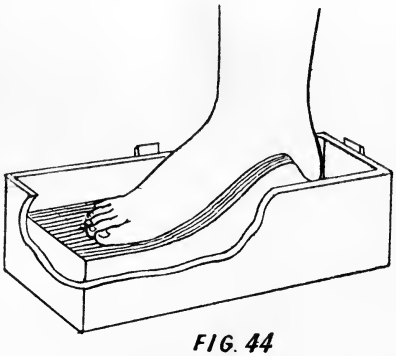

FIG. 44

must be greased. Put the top on the box, and place the foot in position on the hardened greased plaster, and mix some plaster slightly thicker than the first mixing and pour it over the front of the foot, making as straight an edge on either side of the ankle as possible. When this second portion of the mould is set and hardened, any irregularities that may exist should be removed and the edges of the plaster well greased, to prevent the third and last section of the mould adhering. This done, and the foot re-greased and placed back in the box with the sections of the mould completed, some more plaster should be mixed and poured in the back of the box and allowed to set.

To make the cast, the mould is greased well on the inside, and some plaster is mixed, rather thin, and poured into the space in the mould that was originally occupied by the foot, and when set the mould removed, and, if carefully done, an exact counterpart of the foot will be obtained.

The Foot may be measured in three ways: first, by extending it on the leg corresponding to the position of

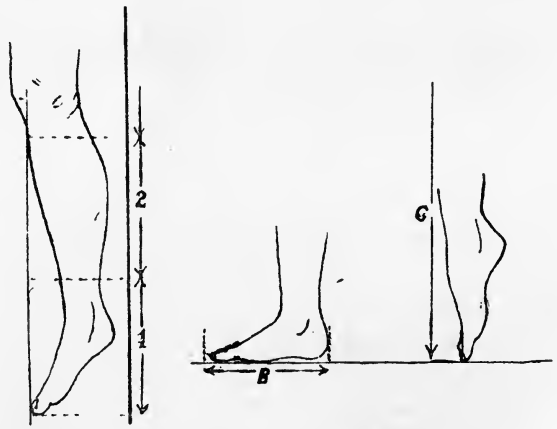

FIG. 45

rest A (Fig. 45), when the line from the knee to the toes will be one quarter of the whole body; secondly, by measuring

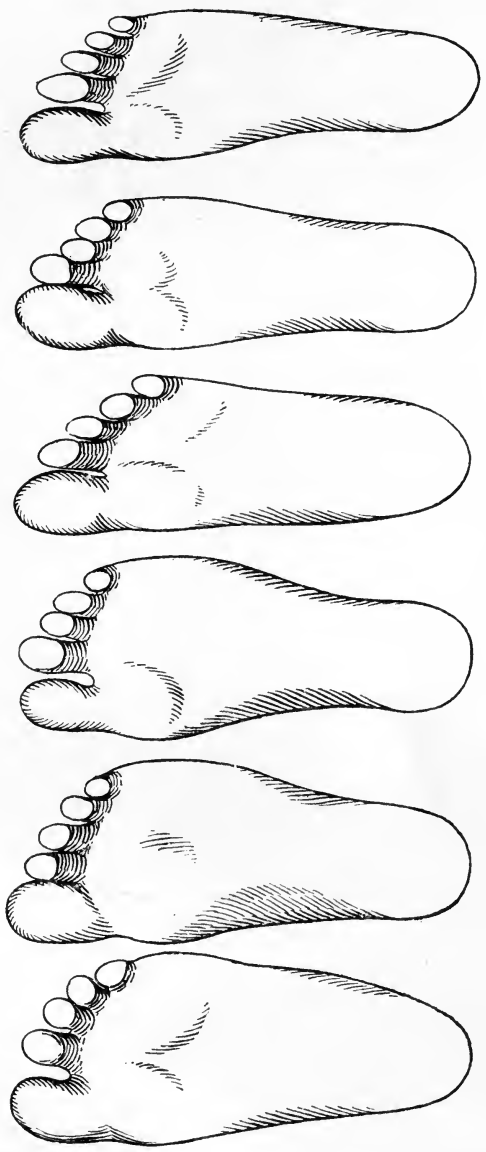

FIG 46 TYPES OF SOLES OF FEET

it as a shoemaker does, with a size-stick B (Fig. 45); and, thirdly, by putting it in the position illustrated by C, and comparing it with the height of the body.

The heel-measure in a foot will largely determine the kind of foot, and the angle made with the ground by the measuring-tape, if recorded, will afford a means of comparing the principal characteristics, such as the height of ankle, and the position of the leg in relation to the foot as measured from an imaginary line at the back of the foot. The line AB (Fig. 39) makes an angle of 35° with the line CD. It should be noted that the proportions of the lines OE OF index the height of ankle and the position of the leg, and that as they approach each other in equality so the foot is more arched. In an arched foot with high instep and ankle the parallelogram OEFB becomes a square. The angles of the heel-line in the illustrations of the types of the various feet are—

	X	Y	Z
Fig. 39	35°	42°	39°
„ 40	45°	38°	42°
„ 41	47°	43°	42°
„ 42	46°	38°	55°

In Fig. 46 is illustrated the types of the soles of feet.

CHAPTER III.

MEASURING THE FOOT: DRAFTS, IMPRESSIONS, APPARATUS, AND MEASUREMENTS.

MEASUREMENTS of the foot are taken for two purposes, either to make boots and shoes to the order of a customer who requires some individual peculiarity to be suited; or for ascertaining *data* for studying and arranging average proportions and relations. The method adopted for the first purpose must not only record girths and lengths, but must give provision for indicating *shape* that may be the cause of the required measurement. The system must also be such that it will be practicably adaptable to the various persons through whose hands it may have to pass, and should record as automatically as possible the position or location of the girth-measurements, thereby preventing any misunderstanding on the part of the makers. The test of a method is its simplicity, combined with accurate and definite information of the characteristics of the foot, that enables a faithful reproduction to be made without liability to error. The first essential to this desirable end is that *uniform* and correct measuring apparatus should be provided; secondly, the same system of measuring the foot and the last should prevail; and, thirdly, the "allowances" should always be made either by the measurer *or* the makers, and not by both, or it may be neither.

When taking measurements, etc., for the compilation or comparison of foot statistics, minute accuracy is more desirable, and apparatus that would be tedious to employ in

the measurements for ordinary bespoke may be used with advantage.

The Size-Stick, used to take the measurements of length, consists of a piece of hard wood—usually boxwood—suitably shaped, and about 18 in. in length. At one end is fixed an upright, forming the beginning of the stick, and another similar upright is made to slide on the stick, which may be adjusted to the object to be measured, giving the shortest length through the body from back to front, as L in Fig. 47. In detail of construction several varieties exist, those having a brass insertion upon which is engraved the divisions (thereby preventing shrinkage to any appreciable extent), and that have a screw or spring (enabling the movable upright to be fixed when required),

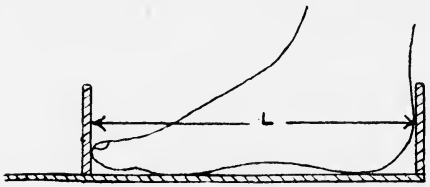

FIG 47

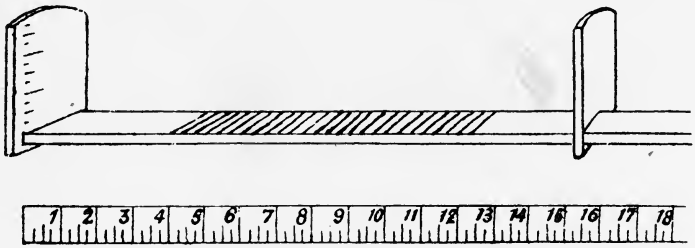

FIG 48

being among the best; while those made with joints so that they may be folded are among the least desirable. Fig. 48 gives an illustration of a standard size-stick, with English and French markings. The uprights are also marked with divisions of inches, enabling heels and "springs" of lasts to be measured. The English sizes marked on the upper edge between the uprights are one-third of an inch, and, strangely, commence notation at $4\frac{1}{3}$ in. from the fixed upright. The numbering of the sizes continues in regular order up

to thirteen, when the notation begins again at one. The French sizes (*Paris points*) are one-third of two centimetres, but begin at the end of the scale, continuing in regular notation throughout the stick. This is a great advantage, and prevents the dual scale of one to thirteen. The inches are usually divided into one-eighths, and the centimetres into one-tenths, and 13 in. approximate 33 centimetres. The frontispiece that faces the title-page gives a full scale of inches (divided into one-ninths) side by side with English shoe sizes. It also shows centimetres and Paris points.

Tape Measures have the sizes printed on one side, and usually inches divided into one-eighths on the other. They should be of good quality, and as unstretchable as possible.* If the sub-divisions are in one-ninths instead of one-eighths, it will be more applicable to the proportions required in the industry. Size tapes and sticks should be tested with a steel standard before use, and the former occasionally during use, preventing any errors through stretching. At the complete inches the sizes are as follows :—

4 inches	0 size	9 inches	2 size
5 „	3 „	10 „	5 „
6 „	6 „	11 „	8 „
7 „	9 „	12 „	11 „
8 „	12 „		

The Measurer should be a careful person, and have sufficient experience to be able to record the peculiarities and differences of the foot measured. The differences between the length and girths of the foot, when measured on the ground with the weight of the body on it, and when taken with the weight *off* the foot, should be understood. In an average adult male foot the difference in measurements of length, joint, instep, and heel girths, and width of bottom are respectively, $\frac{3}{8}$ in., $\frac{3}{8}$ in., $\frac{1}{4}$ in., $\frac{3}{8}$ in., and $\frac{3}{8}$ in.

* Paper scales printed on good Manilla paper are desirable, and, being cheap, may be renewed often.

less than when the foot is measured with the full weight of the body on it. In the average adult female foot these differences would be, length, $\frac{3}{8}$ in.; joint, $\frac{1}{4}$ in.; instep, $\frac{1}{4}$ in.; heel, $\frac{1}{4}$ in.; bottom width, $\frac{1}{4}$ in. The corresponding differences in a child's foot would be, length, $\frac{1}{4}$ in.; joint, $\frac{1}{4}$ in.; instep, $\frac{1}{4}$ in.; heel, $\frac{1}{8}$ in.; bottom width, $\frac{3}{16}$ in.

Feet that may be alike in length and girth are different in many other respects. Some are arched, for instance, and some flat, and these things must be noted by the measurer. Any part out of proportion with the rest of the foot should be recorded. A difference between the feet of a single individual is quite common, and a measurement of both feet should be made in such cases.

The weight, age, and occupation must have consideration. The weight of a person will affect the "allowances" made in the selection or "fitting up" of the last, as the feet of a heavy person will expand more in walking than one whose body is lighter. The age, whether growing or mature, requires attention; as feet that are developing should have all allowances made to permit their growth, without cramping. If the occupation of the person measured involves carrying heavy weights, it should be taken into account when measuring, because when extra weight has to be transmitted to the foot, it expands to a greater degree, and should be treated as a foot of a heavy person.

A bony or a fleshy foot will require different treatment, and the measurer, who usually alone sees the foot, should make the allowances—or at least notify the conditions upon which they may be made. It is preferable, however, to give to the maker the net measurements.

A Draft or Plan of the foot must be taken, upon which the *position* or *location* of the points measured must be indicated. If properly taken it should afford the maker an idea of the arch of the foot, the relative position of the inside and outside joints; whether tapering or square toes; and if corns, bunions, or other malformation be present, the exact situation can be indicated on the draft or plan.

To take the draft, a sheet of paper of suitable size should be placed upon a flat surface, such as the floor, and the foot, with the weight of the body of the person about to be measured, placed on the paper. A *thin* or split lead pencil* held vertically is carried round quite close to the edge of the foot. To indicate the *arch* the pencil is slanted as far under as convenient, and the waist marked. Any special

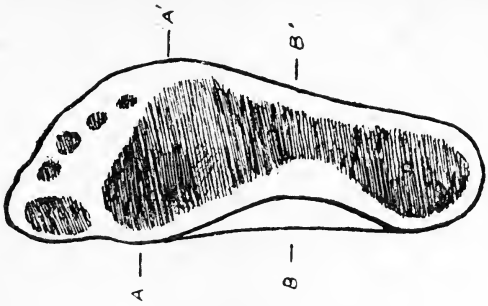

FIG 49

prominence should be indicated, and pencil marks such as AA′, BB′ (Fig. 49), be made to locate the position of joints, instep, etc. Unless this is done, the plan loses the major portion of its usefulness. To ensure the lead pencil being held uprightly when tracing the outline of the foot, a simple piece of apparatus, as shown in Fig. 50, may be used, where A is a section of two triangular-shaped pieces of wood fastened together at right angles. On the face, B, of the larger piece of wood, is affixed two metal grooves to permit a lead pencil to pass to the corner of the apparatus. The edge of the wood that adjoins the point of the pencil is placed near the edge of the foot, and as it is carried round the outline is traced perpendicularly to the margin. A separate pencil is used for the waist.

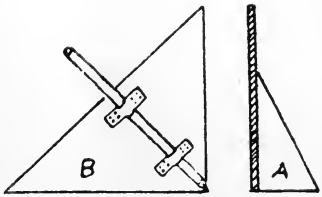

FIG 50.

* A pencil that is used for compasses answers well for this purpose.

It will be observed that in addition to the outline on Fig. 49 there is an impression of the foot, which, if taken, shows the character of the sole and the parts of the foot that give the greatest pressure to the ground.

Foot-Impressions are specially useful when investigating the differences and variations of the sole-area of the foot. They may be produced in several ways. A sheet may be prepared that will do for many impressions on the plan of carbon tracing-paper; or *two* sheets may be used, chemically prepared so that their positions of close contact will give dark impressions, by the chemical combination of two elements that give a distinct colour.

To produce the first kind, take a sheet, or sheets, of white filtering-paper (or any paper that is not glazed or sized), and soak it in a solution made by dissolving aniline dye in spirits of wine, and then adding about an equal quantity of glycerine. After draining and drying it may be used by placing it between some clean filter-paper and the foot placed on the top. This will give two good impressions reversed, one of which may be kept for reference and the other sent to the maker.

The second kind of impression-paper may be made by soaking white filter-paper in a strong solution of tannic acid and allowing to nearly dry. Another sheet must be soaked in a strong solution of chloride of iron and likewise allowed to dry. When using these sheets they are to be faced and the foot placed on the top, when, if the sheets are damp or moist, a clear impression will result. A plan or draft tracing should be made at the same time (Fig. 49).

An Impression-Box may be made that will be more permanent than the paper transfers, and is used abroad for taking foot-impressions. It consists of a frame made of suitable size, upon which is stretched a thin sheet of indiarubber. This membrane is evenly coated with an aniline dye * when used. The frame is hinged to a box upon which is laid a sheet of white paper to take the

* Judson's dyes answer well for this purpose.

impression. The sheet in place, the frame is lowered—the inked side of the rubber being in contact with the paper—and the foot placed on the upper surface of the membrane. When the frame is removed an impression of the sole-area of the foot is found.

The Measures that should be taken are length, girth of joints, instep, heel, ankle, and leg, with the height of ankle and leg from the ground. For long work these (excepting the ankle) and other measurements are required, such as calf, knee; height of calf, knee, etc.

The *joint-girth* is taken round the foot either straight across from the inside joints, or diagonally over the inside and outside joints. If the latter be adopted, their positions must be indicated on the draft. The *instep-measure* is taken round the foot over the top of the instep and under the centre of the foot's arch (Fig. 51, I). The *heel-measurement* is taken round the extreme backward point of the heel, across the throat or bend of the foot. It should not be taken up the leg, but as nearly as possible over the *annular ligament* (Fig. 21, AL, and Fig. 51, H). The *ankle-measure* is taken at the smallest part of the leg above the "ankle" bones. The *leg-measure* is taken at the extreme height required, and its height noted from the ground. The *calf-girth* is taken round the leg at its greatest breadth, and is usually situated from the ground the distance equal to the *heel-girth.* In any case it should be noted how far up it is taken.

The Operation of Measuring.—The person is usually seated, and after the length has been taken by the size-stick *without* * the weight of the body being upon the foot, it is placed upon the ground as in Fig. 51. Or, better still, the draft is *first* taken, and then the toes raised without moving the heel, as shown in the illustration. This will allow the *positions* or *locations* to be marked. The joint is next measured with a tape, snugly passing round the

* The length of the foot *with* the weight of the body is shown by the draft-plan.

foot. To secure the position on the instep for taking the girth the finger should be used to find a slight bony prominence on the inner side of the foot; the tape passing over

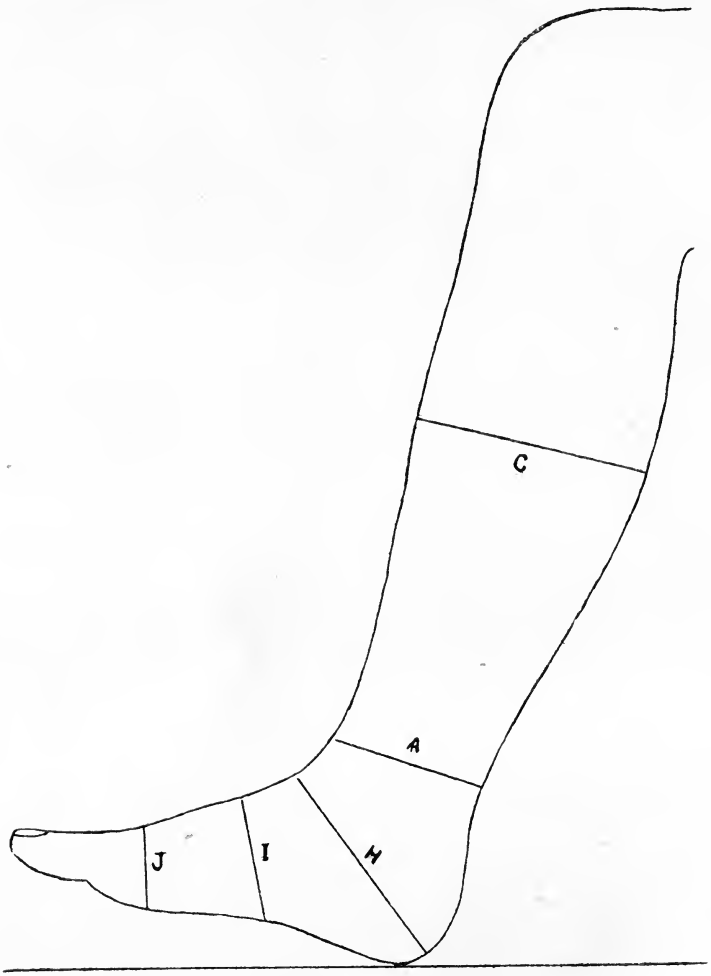

FIG 51

this and under the hollow of the foot. The heel-girth must be carefully taken, and it is advisable to take it when the foot is in a corresponding position to that which it will

occupy when in the boot or shoe with the heel on. This may be accomplished by lowering the toes, and raising the heel to the required height, and then measuring the heel-girth. For high-heeled work this is an important matter, it being essential to the comfort of the wearer, and to prevent the foot going forward in the boot.

Allowances to be made to the measures taken, or whilst taking, in addition to those previously named, are: (*a*) *Length extras*, to allow for the elongation of the foot when the weight of the body is thrown on it; to protect the toes from coming in contact with loose objects; and to allow for the bend or curve of the leather at the toe. Length-increases are rendered necessary, too, when the width of the shoe is not as full as the foot at the joint, so allowing for the longitudinal contraction caused by the spreading of the shoe. (*b*) *Girth increases and decreases*, according to the substance and "give" of the upper and sole, the development of the foot, whether mature or growing.

The following table will show the average length-allowances over the length-measure, taken by the size-stick, without the weight of the body thereon :—

Men's Youths'	3 sizes longer for last.
Women's Boys'	2½ sizes longer for last.
Children's,	2 sizes longer for last.

If the length be measured *with* the weight of the body borne upon the foot, as in taking a draft, the allowance given above will be *reduced* by—

Men's	⅜ inch.
Women's	⅜ „
Children's	¼ „

The girth increases and decreases are given below—

Men's and women's	⅛ in. *less* on joint-girth. ¼ in. *less* on instep-girth.
Youths', boys', and children's ...	⅛ in. *larger* on joint-girth. ⅛ in. *larger* on instep-girth.

These deductions in the adult measures are for soft yielding uppers, and are made to allow for the stretch of leather in wear. The increases in the children's goods are for the usual strong boots that are worn; but if the goods are light and stretchy, they would be made up to measure. If the uppers are *very* stout, no deduction should be made on the adults' and a greater addition should be made for the juvenile requirements. Bony feet are usually made fully up to measure, and feet that are fleshy may be made under the measurement, according to the substance of the boot to be made.

Other Methods of taking Foot-Measurements are sometimes resorted to. One method is to have *two* tapes

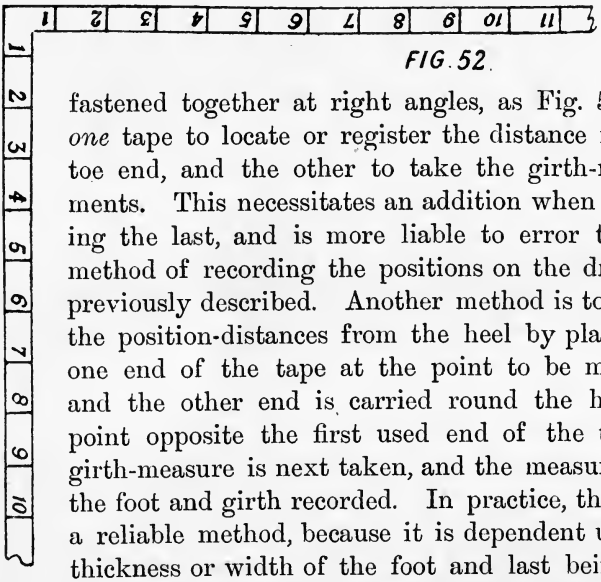

FIG. 52.

fastened together at right angles, as Fig. 52, using *one* tape to locate or register the distance from the toe end, and the other to take the girth-measurements. This necessitates an addition when measuring the last, and is more liable to error than the method of recording the positions on the draft-plan previously described. Another method is to register the position-distances from the heel by placing the one end of the tape at the point to be measured, and the other end is carried round the heel to a point opposite the first used end of the tape. A girth-measure is next taken, and the measure round the foot and girth recorded. In practice, this is not a reliable method, because it is dependent upon the thickness or width of the foot and last being absolutely the same, whereas the last at the seat is usually wider, thus displacing the position-measure.

The American System of taking the measurements is illustrated in Fig. 53, where A is the ball, B the half-ball, C the waist, D the instep, E the long-heel, F the heel, and G the ankle measurements respectively. The long-heel

measurement is a commendable point, and one that may be adapted with considerable advantage. The waist-measure enables the last to be selected, or made, to prevent the wrinkles so common behind the ball of the great toe in work made without taking this measurement.

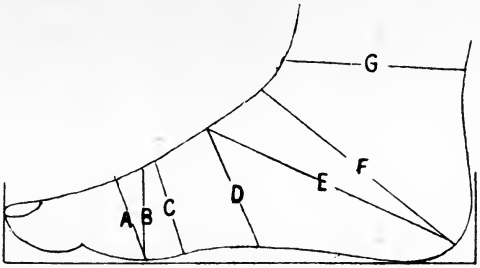

FIG 53

These distances are located on an approved plan. They are all measured by the *size-stick* from the heel in the same manner as the length of the foot is measured. One-half of the length of the foot is taken, and from the bend at the back of the leg above the heel at the ankle; this is measured to the top of the instep, thus locating, longitudinally, the instep position on the foot, that can be measured in a similar way on the last. Three-quarters of the foot's length * measured in like manner from the heel locates the position of the ball-measure. The length of the foot up the leg gives a good position for measuring the leg-girth.

Scott's Podameter consists of a box, one end of which is higher than the other, so that the foot when being measured may be in the same position as it would occupy in the illustration, Fig. 51. At the lower end of the box is fastened a projection that fits round the back of the foot. This is level with the zero of the paper *chart*, that is printed like a size-stick scale. Two guides at one end allow the chart to be slipped under, and it is fastened at the other end. A

* Five-sevenths is more correct.

brass rod runs along the other edge of both sides of the box, and permits a jointed pointer to travel to and fro. When a tape is passed round the foot this pointer is moved along until the point is opposite the centre of the tape, and at the base of pointer on the chart a mark is made, thus locating on the chart the longitudinal position of the measurement. The instruments are all made to one scale, and uniformity in measuring the last and the foot is thereby ensured.

The Heel-Girth Locater is a simple and, for experimental purposes especially, a very useful piece of apparatus.

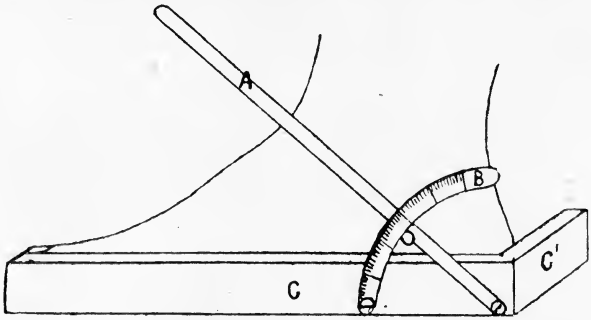

FIG 54

It consists of a piece of wood large enough to allow the placing on of the foot. At one side, and at the back, a rim is fastened, as C in Fig. 54. The movable brass rod A is made to pivot round a centre that coincides with the inside corner edge of the rim C'. A quadrant B, marked with degrees, completes the instrument, with the exception of the guide to prevent the rod A from moving up and down indiscriminately. To use the apparatus, the foot, the heel-measure of which it is desired to locate, is placed on the base-board as shown in Fig. 54. The rod A is adjusted to the position of the heel-girth, and the angle of the rod is read from the quadrant, and recorded.

Ellis's Pedistat consists of a platform, A (Fig. 55), twelve inches long and four wide. At one end of this is a block, against which the heel is placed. Outside the borders of the

platform are two grooves, EE, along which two upright pillars, CC, may slide. The edges BB, outside the grooves

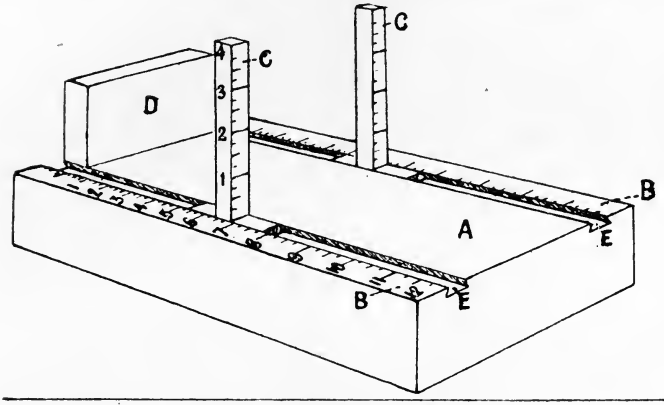

FIG. 55 ELLIS' PEDISTAT.

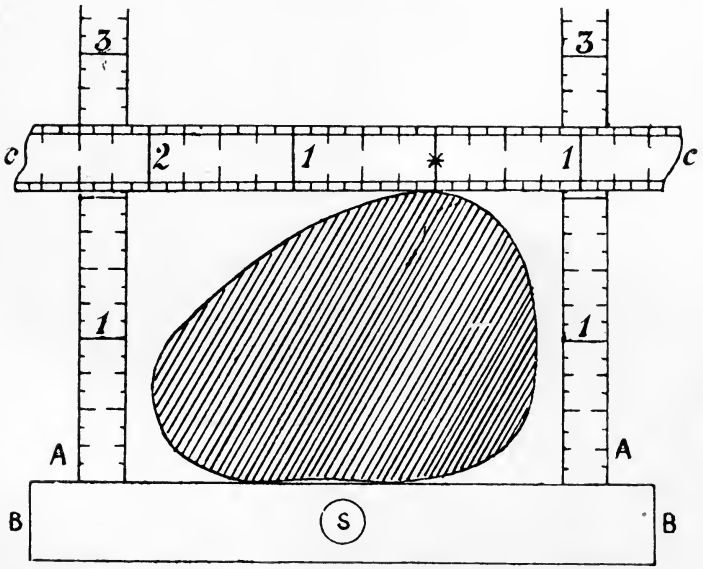

FIG. 56

EE, are marked with inches, sub-divided into one-eighths numbered from the heel-block. The pillars are also

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graduated, dating from the platform level. The usage of the instrument is illustrated by Fig. 56, where S is the milled screw that moves to and fro the pillars AA. A movable rule, *cc*, is provided with a scale either side from the centre. The shaded portion is a section of a cast of a foot made across the instep. The pillars AA are brought along the groove EE (Fig. 55) until opposite the *position* of the top of the instep, and the length indicated on the scale BB (Fig. 55) noted. The rule *cc* (Fig. 56) is now taken, and the starred centre put over the highest part, and the height of the under edge of the rule noted on the pillars AA, and the distances of the "star" from the inside edges of the pillars recorded respectively as inside and outside distances. The point of the highest part of the instep would thus be accurately located by three dimensions.

Plans and Elevations of the foot and leg are sometimes taken, and this in the case of orthopœdic work is necessary. It may be taken in several ways, but the simplest plan is to take two hinged boards, as illustrated in Fig. 57, and fasten to the board that is to be used as a base, by means of drawing-pins or tacks, a sheet of paper. The foot is now placed on this portion of the paper and a draft outline taken. Without moving the foot the other board is brought in position as illustrated, and fastened by the hook provided. The paper is pinned to the upright board, and an elevation outline of the foot and leg marked. The positions or locations where the various girth-measures are taken may be marked on the

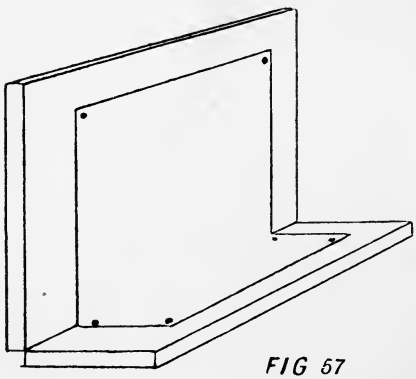


FIG 57

plan and elevation. A little platform may be added to the base, regulated by a screw, so that the height of heel may be imitated and allowed for in the tracings.

Some variations in the methods described are sometimes made, such as substituting a paper strip in place of the tape-measure for taking the girths, and by a slight transverse tear on one edge, the joint, instep, and heel is registered. The other edge of the paper slip records the ankle and leg measure.

An additional joint and instep measure is also sometimes taken, termed past or second joint, and lower or second instep measurements respectively.

It is a good plan to have printed (or purchase) "bespoke measurement sheets" that give on one side space for taking plan-drafts, and printed spaces for systematically recording the measurements and peculiarities. On the other side of the sheet should be printed the method of taking the measures, which, if carefully followed, would ensure the measurer and the various hands through which the "measure" may pass adopting the same uniform system.

Classed Standard Measures.—The average well-formed foot could be classed, and a table prepared giving the measurements of the various classes. If standard feet measurements were adopted, and the allowances for substances of materials, etc., agreed upon, it would be possible to avoid the misunderstandings so common with standard last measurements. For instance, a standard foot-measure for a lady's *foot* measuring in state of repose would be (say), length, $1\frac{1}{2}$ sizes; bottom-width, 3 in.; joint, 8 in.; instep, $8\frac{1}{2}$ in. Add the length-allowance of $2\frac{1}{2}$ sizes, this would give size 4's. Deduct for light material, $\frac{1}{4}$ in. on instep and $\frac{1}{8}$ in. on joints, giving joint $7\frac{7}{8}$ in. and instep $8\frac{1}{4}$ in. If for heavy material, the deduction would not be made, and for other classes fixed allowances would be made. Supposing this were called (say) "C" foot, it could be so stamped on the lasts and boots, with a letter or figure denoting the allowance.

This, if properly carried out, would enable the person who possessed this foot to always obtain a boot or shoe that would be of suitable measurement to suit the kind of foot, without causing a large variety of measures to be in existence without denomination, such as is found under the now marked "3 fitting." The difference in widths and girths are usually termed "fittings," and are numbered 0 to 6. They are also named as follows :—

0, Narrow fitting.
1, Slim fitting.
2, Smart fitting.
3, Medium fitting.
4, Full fitting.
5, Wide or extra full fitting.
6, Extra wide or XX full fitting.

The joint-girth usually decides the fitting, but a fitting should not merely be an increase or decrease in circumference. The reason of the differences required in fittings is due to the various stages of development of feet, and the shape-characteristics must be provided for, besides the girths. For instance, a narrow or slim foot has the joints undeveloped, and gives the appearance of an arched instep, while a broad foot would appear to have a low instep. The difference between the instep and joint measurements is greater in the slim foot than is found in the wide foot. The larger the fitting the less the difference between the joint and instep measures, and the smaller the fitting the greater the difference. This difference is termed "rise." In a well-developed or wide foot, the joint is found to have developed in a greater degree than the instep, hence there is less rise. Feet do not vary so much in the posterior as in the anterior portion.

The Principles upon which a Scale of Measurements should be based are: first, that as the length-measures are of equal length throughout the scale ($\frac{1}{3}$ in.), so should the various girth-measurements be equal throughout their respective ranges.

For instance, the amount adopted for *joint-girth* increase should be the same between any two consecutive sizes as between any other two *joint-girth* measurements in the same range.

The same amount, however, must not be used both for *joint-girth* and *instep-girth*, as the joint are greater than the instep increases.

Secondly, that a greater difference should exist in the rise of adult measurements than in infants'.

In some cases this rule has been applied coupled with another that, however, is not quite accurate; viz. that in a last of half the length of an adult there should be one-half the rise. "Alden's" scale is based upon this rule.

Thirdly, that in the measurements of girth between size and size, the difference between the joint and instep girths—*i.e.* "rise"—*increases* from the smaller to the larger sizes, but in the "fitting" measurements the rise *decreases* from the smaller to the larger fitting.

For instance, in *sizes*, the rise between an adult measure would be, say, $\frac{1}{2}$ in.; whereas in the infants' it would only be, say, $\frac{1}{4}$ in., with a graduation between, In *fittings*, the rise in adults' would be, say, $\frac{1}{2}$ in.; in a *larger* fitting it would be less, say $\frac{2}{8}$ in., and in smaller fittings it would be greater, say $\frac{6}{8}$ in.

Fourthly, the difference between "fitting" measurements in infants' should be less than in adults'.

If the difference between joint and joint of "fittings" in adults' be, say, $\frac{5}{18}$ in., the infants' would be, say, $\frac{5}{36}$ in.

A scale of measurements that contain these requirements will be suitable to the development of feet, and if the proper *shape* be given to the infants' and adults' respectively, with the alterations required for fittings, a reliable table will be obtained suitable for average-proportioned feet.

An Examination of the Tables of Measurements of Lasts now in Use, will show that there are few that comply with the requisite conditions. The scales used in England are many, and each person adopts his own standard, so that uniformity is not found even in the scales of a district or a manufacturer. Nearly all the scales in use are not conformable to the *first* essential principle. The various tables may be grouped as "$\frac{1}{4}$-in. system," "irregular graduation," "$\frac{1}{3}$-in. method," "Alden's method," etc.

The Quarter-inch System is supposed to be based upon the rule that a difference of a quarter of an inch increase or decrease should be made between size and size and fitting and fitting, both for instep and joint girths. The advantage claimed for this method is that an easy unit is used, and awkward fractions are avoided. Its inaccuracy is not so noticeable when only a very short range of sizes are used, but where a larger run is required the system cannot be adhered to. This difference for joints is too great, consequently the measurements of a small size produced by this method would be too small, and to obviate this, "breaks" are made in the scale, and the girths of two sizes are made the same at various places. Again, a complete scale of fittings could not be used based upon this rule that would give the measurements required for a proper last.

The scale given below is the one most used—

MEN'S.

Men's joints.	1 fitt.	2 fitt.	3 fitt.	4 fitt.	5 fitt.
Size 11	$9\frac{1}{4}$	$9\frac{1}{2}$	$9\frac{3}{4}$	10	$10\frac{1}{4}$
„ 10	9	$9\frac{1}{4}$	$9\frac{1}{2}$	$9\frac{3}{4}$	10
„ 9	$8\frac{3}{4}$	9	$9\frac{1}{4}$	$9\frac{1}{2}$	$9\frac{3}{4}$
„ 8	$8\frac{1}{2}$	$8\frac{3}{4}$	9	$9\frac{1}{4}$	$9\frac{1}{2}$
„ 7	$8\frac{1}{4}$	$8\frac{1}{2}$	$8\frac{3}{4}$	9	$9\frac{1}{4}$
„ 6	8	$8\frac{1}{4}$	$8\frac{1}{2}$	$8\frac{3}{4}$	9
„ 5	$7\frac{3}{4}$	8	$8\frac{1}{4}$	$8\frac{1}{2}$	$8\frac{3}{4}$

Youths'.

Youths' joints.	1 fitt.	2 fitt.	3 fitt.	4 fitt.	5 fitt.
Size 4	7½	7¾	8	8½	8½
„ 3	7¼	7½	7¾	8	8¼
„ 2	7	7¼	7½	7¾	8
„ 1	6¾	7	7¼	7½	7¾
„ 13	6¾	7	7¼	7½	7¾
„ 12	6½	6¾	7	7¼	7½
„ 11	6¼	6½	6¾	7	7¼

Boys'.

Boys' joints.	1 fitt.	2 fitt.	3 fitt.	4 fitt.	5 fitt.
Size 10	6¼	6½	6¾	7	7¼
„ 9	6	6¼	6½	6¾	7
„ 8	5¾	6	6¼	6½	6¾
„ 7	5½	5¾	6	6¼	6½

Women's.

Women's joints.	1 fitt.	2 fitt.	3 fitt.	4 fitt.	5 fitt.
Size 7	8	8¼	8½	8¾	9
„ 6	7¾	8	8¼	8½	8¾
„ 5	7½	7¾	8	8¼	8½
„ 4	7¼	7½	7¾	8	8¼
„ 3	7	7¼	7½	7¾	8
„ 2	6¾	7	7¼	7½	7¾

Girls'.

Girls' joints.	1 fitt.	2 fitt.	3 fitt.	4 fitt.	5 fitt.
Size 13	6½	6¾	7	7¼	7½
„ 12	6¼	6½	6¾	7	7¼
„ 11	6	6¼	6½	6¾	7
„ 10	6	6¼	6½	6¾	7
„ 9	5¾	6	6¼	6½	6¾
„ 8	5½	5¾	6	6¼	6½
„ 7	5¼	5½	5¾	6	6¼

CHILDREN'S.

Children's joints.	1 fitt.	2 fitt.	3 fitt.	4 fitt.	5 fitt.
Size 6	$5\frac{1}{4}$	$5\frac{1}{2}$	$5\frac{3}{4}$	6	$6\frac{1}{4}$
,, 5	5	$5\frac{1}{4}$	$5\frac{1}{2}$	$5\frac{3}{4}$	6
,, 4	$4\frac{3}{4}$	5	$5\frac{1}{4}$	$5\frac{1}{2}$	$5\frac{3}{4}$
,, 3	$4\frac{1}{2}$	$4\frac{3}{4}$	5	$5\frac{1}{4}$	$5\frac{1}{2}$
,, 2	$4\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{3}{4}$	5	$5\frac{1}{4}$
,, 1	4	$4\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{3}{4}$	5

The rise, or difference between joint and instep, for the above would be—

Men's and women's	$\frac{1}{2}$ inch.
Youths' (2–5) and girls' (11–1)	$\frac{3}{8}$,,
Boys' (11–1) and girls' (7–10)	$\frac{1}{4}$,,
Boys' (7–10) and children's (1–6)	$\frac{1}{8}$,,

SCALE OF BOTTOM-WIDTHS.

	Tread.	Seat.
Men's size 7 (3 fitt.)	$3\frac{1}{4}$ ...	$2\frac{12}{16}$
Women's size 4 ,, ...	$2\frac{7}{4}$ ...	$2\frac{1}{16}$
Youths' size 4 ,, ...	$2\frac{7}{8}$ ...	$2\frac{1}{8}$

The tread to be increased or decreased from size to size by $\frac{1}{9}$ in., and from fitting to fitting by $\frac{1}{8}$ in. The seat to be increased or decreased from size to size by $\frac{1}{12}$ in., and from fitting to fitting by $\frac{3}{32}$ in. for men's.

For women's :—

Tread (size to size)	$\frac{1}{10}$ inch.
,, (fitt. to fitt.)	$\frac{1}{8}$,,
Seat (size to size)	$\frac{1}{16}$,,
,, (fitt. to fitt.)	$\frac{1}{16}$,,

Irregular Gradations.—To maintain simplicity of measurement notation, and to obviate the making of two girths of the same dimensions, several methods are adopted that may be termed irregular. One of these systems has a difference of $\frac{1}{8}$ in. between the joint-girths of the 6, 7, 8, and 9; $\frac{3}{16}$ in. between the 10, 11, 12, and 13; and $\frac{1}{4}$ in. between the 1, 2, 3, 4, 5, 6, 7, and 8. The instep-girths in this scale increase $\frac{3}{16}$ in. between the 6's and 1's, and $\frac{1}{4}$ in. between the 1's and 8's. The best method

upon this principle is to make a difference in joint-girth of $\frac{3}{16}$ in. from size 1 ($4\frac{1}{3}$ in.) to size 10 ($7\frac{1}{3}$ in.) and $\frac{1}{4}$ in. for the rest of the scale for males, and $\frac{3}{16}$ in. from size 1 ($4\frac{1}{3}$ in.) to size 1 ($8\frac{2}{3}$ in.) for females. The scale is given below with tread and seat measurements :—

MALE SCALE (3 fitt.).

Sizes.	Joint.	Instep.	Tread.	Seat.
1	$4\frac{9}{16}$	$4\frac{21}{32}$	$1\frac{3}{4}$	$1\frac{3}{16}$
2	$4\frac{3}{4}$	$4\frac{27}{32}$	$1\frac{13}{16}$	$1\frac{1}{4}$
3	$4\frac{15}{16}$	$5\frac{1}{32}$	$1\frac{7}{8}$	$1\frac{5}{16}$
4	$5\frac{1}{8}$	$5\frac{7}{32}$	$1\frac{15}{16}$	$1\frac{3}{8}$
5	$5\frac{5}{16}$	$5\frac{13}{32}$	2	$1\frac{7}{16}$
6	$5\frac{1}{2}$	$5\frac{19}{32}$	$2\frac{1}{12}$	$1\frac{1}{2}$
7	$5\frac{11}{16}$	$5\frac{7}{8}$	$2\frac{1}{6}$	$1\frac{9}{16}$
8	$5\frac{7}{8}$	$6\frac{1}{16}$	$2\frac{1}{4}$	$1\frac{5}{8}$
9	$6\frac{1}{16}$	$6\frac{1}{4}$	$2\frac{1}{3}$	$1\frac{11}{16}$
10	$6\frac{1}{4}$	$6\frac{7}{16}$	$2\frac{5}{12}$	$1\frac{3}{4}$
11	$6\frac{1}{2}$	$6\frac{25}{32}$	$2\frac{1}{2}$	$1\frac{13}{16}$
12	$6\frac{3}{4}$	$7\frac{1}{32}$	$2\frac{7}{12}$	$1\frac{7}{8}$
13	7	$7\frac{9}{32}$	$2\frac{2}{3}$	$1\frac{15}{16}$
1	$7\frac{1}{4}$	$7\frac{17}{32}$	$2\frac{3}{4}$	2
2	$7\frac{1}{2}$	$7\frac{25}{32}$	$2\frac{5}{6}$	$2\frac{1}{16}$
3	$7\frac{3}{4}$	$8\frac{1}{32}$	$2\frac{11}{12}$	$2\frac{1}{8}$
4	8	$8\frac{9}{32}$	3	$2\frac{3}{16}$
5	$8\frac{1}{4}$	$8\frac{17}{32}$	$3\frac{1}{12}$	$2\frac{1}{4}$
6	$8\frac{1}{2}$	$8\frac{7}{8}$	$3\frac{1}{6}$	$2\frac{5}{16}$
7	$8\frac{3}{4}$	$9\frac{1}{4}$	$3\frac{1}{4}$	$2\frac{3}{8}$
8	9	$9\frac{3}{8}$	$3\frac{1}{3}$	$2\frac{7}{16}$
9	$9\frac{1}{4}$	$9\frac{5}{8}$	$3\frac{5}{12}$	$2\frac{1}{2}$
10	$9\frac{1}{2}$	$9\frac{7}{8}$	$3\frac{1}{2}$	$2\frac{9}{16}$

FEMALE SCALE (3 fitt.).

Sizes.	Joint.	Instep.	Tread.	Seat.
1	$4\frac{9}{16}$	$4\frac{11}{16}$	$1\frac{3}{4}$	$1\frac{5}{16}$
2	$4\frac{3}{4}$	$4\frac{7}{8}$	$1\frac{13}{16}$	$1\frac{23}{64}$
3	$4\frac{15}{16}$	$5\frac{1}{16}$	$1\frac{7}{8}$	$1\frac{13}{32}$
4	$5\frac{1}{8}$	$5\frac{1}{4}$	$1\frac{15}{16}$	$1\frac{29}{64}$
5	$5\frac{5}{16}$	$5\frac{7}{16}$	2	$1\frac{1}{2}$
6	$5\frac{1}{2}$	$5\frac{5}{8}$	$2\frac{1}{16}$	$1\frac{35}{64}$
7	$5\frac{11}{16}$	$5\frac{15}{16}$	$2\frac{1}{8}$	$1\frac{19}{32}$
8	$5\frac{7}{8}$	$6\frac{1}{8}$	$2\frac{3}{16}$	$1\frac{41}{64}$
9	$6\frac{1}{16}$	$6\frac{5}{16}$	$2\frac{1}{4}$	$1\frac{11}{16}$
10	$6\frac{1}{4}$	$6\frac{1}{2}$	$2\frac{5}{16}$	$1\frac{47}{64}$
11	$6\frac{7}{16}$	$6\frac{13}{16}$	$2\frac{3}{8}$	$1\frac{25}{32}$
12	$6\frac{5}{8}$	7	$2\frac{7}{16}$	$1\frac{53}{64}$

FEMALE SCALE (3 fitt.)—(*continued*).

Sizes.	Joint.	Instep.	Tread.	Seat.
13	$6\frac{13}{16}$	$7\frac{3}{16}$	$2\frac{1}{2}$	$1\frac{7}{8}$
1	7	$7\frac{3}{8}$	$2\frac{9}{16}$	$1\frac{59}{64}$
2	$7\frac{1}{4}$	$7\frac{3}{4}$	$2\frac{5}{8}$	$1\frac{31}{32}$
3	$7\frac{1}{2}$	8	$2\frac{11}{16}$	$2\frac{1}{64}$
4	$7\frac{3}{4}$	$8\frac{1}{4}$	$2\frac{3}{4}$	$2\frac{1}{16}$
5	8	$8\frac{1}{2}$	$2\frac{13}{16}$	$2\frac{7}{64}$
6	$8\frac{1}{4}$	$8\frac{3}{4}$	$2\frac{7}{8}$	$2\frac{5}{32}$
7	$8\frac{1}{2}$	9	$2\frac{15}{16}$	$2\frac{13}{64}$

The American Standard Measurements are recognized throughout the American last industry. The fittings are lettered instead of numbered. Below is the standard size 7's and 10's men's in three widths, C, D, and E.

	Size.	Ball.	Instep.	Long-heel.	Bottom.
Width C	7	$8\frac{1}{8}$	9	$12\frac{2}{8}$	3
„	10	$9\frac{3}{8}$	$9\frac{6}{8}$	13	$3\frac{6}{64}$
Width D	7	$8\frac{6}{8}$	$9\frac{2}{8}$	$12\frac{4}{8}$	$3\frac{2}{24}$
„	10	$9\frac{4}{8}$	10	$13\frac{2}{8}$	$3\frac{8}{24}$
Width E	7	9	$9\frac{4}{8}$	$12\frac{6}{8}$	$3\frac{4}{24}$
„	10	$9\frac{6}{8}$	$10\frac{2}{8}$	$13\frac{4}{8}$	$3\frac{10}{24}$

The Ninth System of arranging the measurements is a good one, as there are no "breaks" in the gradation, and the girths are suitable for the foot's development. The standard from which the measures are taken is ladies' size 4, and for the joints and insteps would be as follows:—

	1 fitt.	2 fitt.	3 fitt.	4 fitt.	5 fitt.	6 fitt.
Joints	$7\frac{4}{9}$	$7\frac{7}{9}$	$7\frac{8}{9}$	$8\frac{1}{9}$	$8\frac{4}{9}$	$8\frac{5}{9}$
Instep	$8\frac{1}{9}$	$8\frac{2}{9}$	$8\frac{3}{9}$	$8\frac{4}{9}$	$8\frac{5}{9}$	$8\frac{2}{3}$

A difference of $\frac{2}{9}$ in. is made between size and size and fitting and fitting for the joint and instep measurement. This arrangement would give the rises for the different fittings suitable to the requirements of the foot, being $\frac{6}{9}$ in. in the one fitting and $\frac{1}{9}$ in. in the six fitting. Its objection is that it gives the same rise for adults and infants.

Alden's Method of arranging the measurements is a practicable one, and consists in establishing a standard measure of girths *that has been found by experience to*

be suitable and correct. This is taken as size 8's in men's and 4's in women's, and would be $9\frac{1}{8}$ joints and $9\frac{1}{2}$ instep for the men's, and $7\frac{7}{8}$ joints and $8\frac{1}{4}$ instep for the women's. At the other end of the scale about to be made, another measurement, that experience has found to be correct, is selected, and the intermediate difference between the respective girths is subdivided into as many *equal* parts as there are *sizes* intervening. This latter part of the system is highly approved, as it obviates the expression of fractions, that would be difficult to practicably utilize, while at the same time the accuracy of the sub-division is maintained. The system will be illustrated by reference to the production of a women's and girls' scale.

The women's standard is size 4, the length of which is $9\frac{2}{3}$ in. One-half this length is size $2\frac{1}{2}$ ($4\frac{5}{8}$ in.), and this is the other smaller standard selected—

	Joints.	Instep.	Tread.
Women's, size 4	$7\frac{7}{8}$	$8\frac{1}{4}$	$2\frac{3}{4}$
Children's, size $2\frac{1}{2}$	$4\frac{13}{16}$	5	$1\frac{25}{32}$

To obtain the intermediate sizes the differences between these two extremes is divided into $14\frac{1}{2}$, the number of sizes between $2\frac{1}{2}$ and 4. To complete the scale of fittings, $\frac{9}{32}$ in. is added to the adult joints for the larger fittings, and *one-half* this, *i.e.* $\frac{9}{64}$ for the child's. To obtain the insteps, $\frac{7}{32}$ in. is added to the adult, and *one-half* this, *i.e.* $\frac{7}{64}$, to infants'. The adult tread is increased by $\frac{2}{16}$ in. for each fitting larger, and *one-half*, $\frac{2}{32}$, for infants' bottom-widths.

ALDEN'S SCALE.

	Fitt. 1.	Fitt. 2.	Fitt. 3.	Fitt. 4.	Fitt. 5.	Difference.
Children's $2\frac{1}{2}$, joint-girth ...	$4\frac{34}{64}$	$4\frac{43}{64}$	$4\frac{52}{64}$	$4\frac{61}{64}$	$5\frac{6}{64}$	$\frac{9}{64}$
„ $2\frac{1}{2}$, instep-girth...	$4\frac{50}{64}$	$4\frac{57}{64}$	5	$5\frac{7}{64}$	$5\frac{14}{64}$	$\frac{7}{64}$
„ $2\frac{1}{2}$, rise ...	$\frac{16}{64}$	$\frac{14}{64}$	$\frac{12}{64}$	$\frac{10}{64}$	$\frac{8}{64}$	$\frac{2}{64}$
„ $2\frac{1}{2}$, tread-width...	$1\frac{21}{32}$	$1\frac{23}{32}$	$1\frac{25}{32}$	$1\frac{27}{32}$	$1\frac{29}{32}$	$\frac{2}{32}$
Women's 4, joint-girth ...	$7\frac{10}{32}$	$7\frac{19}{32}$	$7\frac{28}{32}$	$8\frac{5}{32}$	$8\frac{14}{32}$	$\frac{9}{32}$
„ 4, instep-girth ...	$7\frac{26}{32}$	$8\frac{1}{32}$	$8\frac{8}{32}$	$8\frac{15}{32}$	$8\frac{22}{32}$	$\frac{7}{32}$
„ 4, rise	$\frac{16}{32}$	$\frac{14}{32}$	$\frac{12}{32}$	$\frac{10}{32}$	$\frac{8}{32}$	$\frac{2}{32}$
„ 4, tread-width ...	$2\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{7}{8}$	3	$\frac{1}{8}$

To construct the completion of the scales it is necessary to subdivide the various measurements, which may be done as follows:—Draw a line AB (Fig. 58), and upon it mark as many sizes ($\frac{1}{3}$ in.) as there are intervening between the extremes. In this case there are $14\frac{1}{2}$, numbered $2\frac{1}{2}$ to 4. Through each of these divisions erect perpendicular lines, and make the two extremes, $2\frac{1}{2}$ and 4, measure respectively $1\frac{25}{32}$ and $2\frac{3}{4}$, if the tread-widths were being obtained. Connect these two points ($1\frac{25}{32}$ and $2\frac{3}{4}$, Fig. 58) by a straight line, and where it crosses the several perpendicular lines it will give the widths for all the sizes, measured from the line AB.

The joint, instep, and widths are marked on a slip of paper, a separate strip being used for each fitting.

An Improved Scale of Measurements is drawn on the front piece, side by side with English and French length-measures. They are arranged for lasts to make medium-substance goods upon, and should be increased or decreased by $\frac{1}{9}$ in. for stouter and lighter work respectively for girth-measurements, and $\frac{1}{18}$ in. for bottom-widths. The scale contains all the vital principles of a correct scale, and has an advantage of expressed dimensions. It is given in six fittings, and the outside measurements are for size 1 ($4\frac{1}{3}$ in. length) and size 4 ($9\frac{2}{3}$ in. length), thus giving sixteen sizes between.

SCALE OF MEASUREMENTS FOR LASTS (Medium Work).

Joints.

Fittings.	Size 1.	Size 4.	Total difference.	Difference per size.
0	4	$7\frac{1}{18}$	$3\frac{1}{18}$	$\frac{55}{288}$
1	$4\frac{3}{18}$	$7\frac{1}{3}$	$3\frac{3}{18}$	$\frac{57}{288}$
2	$4\frac{3}{9}$	$7\frac{11}{18}$	$3\frac{5}{18}$	$\frac{59}{288}$
3	$4\frac{1}{2}$	$7\frac{8}{9}$	$3\frac{7}{18}$	$\frac{61}{288}$
4	$4\frac{2}{3}$	$8\frac{1}{6}$	$3\frac{1}{2}$	$\frac{63}{288}$
5	$4\frac{5}{6}$	$8\frac{4}{9}$	$3\frac{11}{18}$	$\frac{65}{288}$
6	5	$8\frac{13}{18}$	$3\frac{13}{18}$	$\frac{67}{288}$
Increase	$\frac{3}{18}$	$\frac{5}{18}$	$\frac{1}{9}$	$\frac{1}{144}$

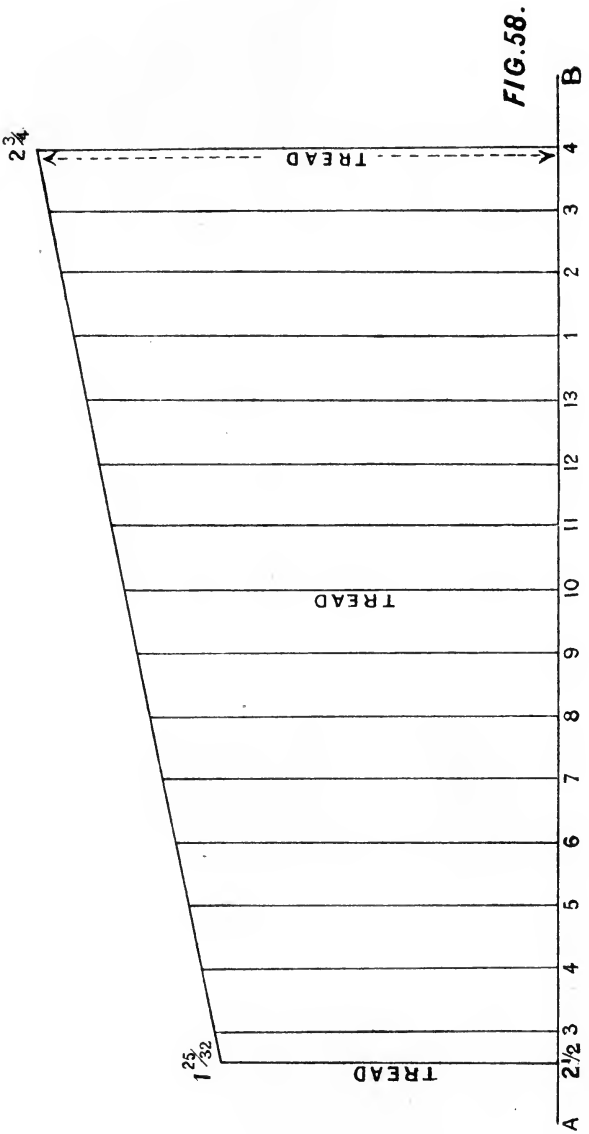


FIG. 58.

Bottom-Widths.

Fittings.	Size 1.	Size 4.	Total difference.	Difference per size.
0	$1\frac{19}{36}$	$2\frac{17}{36}$	$\frac{17}{18}$	$\frac{17}{288}$
1	$1\frac{21}{36}$	$2\frac{21}{36}$	1	$\frac{18}{288}$
2	$1\frac{23}{36}$	$2\frac{25}{36}$	$1\frac{1}{18}$	$\frac{19}{288}$
3	$1\frac{25}{36}$	$2\frac{29}{36}$	$1\frac{1}{9}$	$\frac{20}{288}$
4	$1\frac{27}{36}$	$2\frac{33}{36}$	$1\frac{2}{18}$	$\frac{21}{288}$
5	$1\frac{29}{36}$	$3\frac{1}{36}$	$1\frac{2}{9}$	$\frac{22}{288}$
6	$1\frac{31}{36}$	$3\frac{5}{36}$	$1\frac{5}{18}$	$\frac{23}{288}$
Increase	$\frac{1}{18}$	$\frac{1}{9}$	$\frac{1}{18}$	$\frac{1}{288}$

Insteps.

Fittings.	Size 1.	Rise over joint.	Size 4.	Rise over joint.	Difference between the girths.	Difference per size.	Rise increase per size.
0	$4\frac{7}{18}$	$\frac{7}{18}$	$7\frac{15}{18}$	$\frac{7}{9}$	$3\frac{4}{9}$	$\frac{31}{144}$	$\frac{7}{288}$
1	$4\frac{1}{2}$	$\frac{3}{9}$	8	$\frac{6}{9}$	$3\frac{1}{2}$	$\frac{63}{288}$	$\frac{3}{144}$
2	$4\frac{11}{18}$	$\frac{5}{18}$	$8\frac{3}{18}$	$\frac{5}{9}$	$3\frac{5}{9}$	$\frac{32}{144}$	$\frac{5}{288}$
3	$4\frac{13}{18}$	$\frac{2}{9}$	$8\frac{2}{9}$	$\frac{4}{9}$	$3\frac{11}{18}$	$\frac{65}{288}$	$\frac{2}{144}$
4	$4\frac{15}{18}$	$\frac{3}{18}$	$8\frac{1}{2}$	$\frac{3}{9}$	$3\frac{6}{9}$	$\frac{33}{144}$	$\frac{3}{288}$
5	$4\frac{17}{18}$	$\frac{1}{9}$	$8\frac{6}{9}$	$\frac{2}{9}$	$3\frac{13}{18}$	$\frac{67}{288}$	$\frac{1}{144}$
6	$5\frac{1}{18}$	$\frac{1}{18}$	$8\frac{15}{18}$	$\frac{1}{9}$	$3\frac{7}{9}$	$\frac{34}{144}$	$\frac{1}{288}$
Increase	$\frac{1}{9}$	$\frac{1}{18}$	$\frac{1}{6}$	$\frac{1}{9}$	$\frac{1}{18}$	$\frac{1}{288}$	$\frac{1}{288}$

Seats.

Fittings.	Size 1.	Size 4.	Difference between seats.	Difference per size.
0	$1\frac{13}{72}$	$1\frac{31}{36}$	$\frac{49}{72}$	$\frac{12\frac{1}{4}}{288}$
1	$1\frac{2}{9}$	$1\frac{17}{18}$	$\frac{13}{18}$	$\frac{13}{288}$
2	$1\frac{19}{72}$	$2\frac{1}{36}$	$\frac{55}{72}$	$\frac{13\frac{3}{4}}{288}$
3	$1\frac{11}{36}$	$2\frac{1}{9}$	$\frac{29}{36}$	$\frac{14\frac{1}{2}}{288}$
4	$1\frac{25}{72}$	$2\frac{7}{36}$	$\frac{61}{72}$	$\frac{15\frac{1}{4}}{288}$
5	$1\frac{7}{18}$	$2\frac{5}{18}$	$\frac{8}{9}$	$\frac{16}{288}$
6	$1\frac{31}{72}$	$2\frac{13}{36}$	$\frac{67}{72}$	$\frac{16\frac{3}{4}}{288}$
Increase	$\frac{3}{72}$	$\frac{3}{36}$	$\frac{3}{72}$	$\frac{\frac{3}{4}}{288}$

Heel-Measures.—There are two measurements that are usually termed heel-measures—one the distance round the foot as usually taken, and the other the long-heel, a measure especially useful in lasts. The latter is taken from the top of the instep, from the same point used to take the instep-girth, and round the corner of the seat of the last. Both of these measures, the *heel-girth* and the *long-heel*, may be approximately calculated from the table given—

Let a = instep measure;
b = long-heel measure;
r = rise;
c = heel-girth.

Then $a + \frac{1}{3}a + \frac{1}{2}r = c$ adults'
$a + \frac{1}{3}a - r = c$ children's
$a + \frac{1}{5}a - r = b$ children's
$a + \frac{1}{2}a = b$ adults'.

French Standard Measurements.—The standard for men's size 41 (*Paris points*), or $27\frac{1}{2}$ centimetres, is—

Joints	...	...	...	22	centimetres.
Instep	...	...	...	$23\frac{1}{2}$	,,
Heel	...	...	...	$32\frac{1}{2}$	,,
Ankle	...	...	...	22	,,

and for ladies' size 37 (*Paris points*), or $24\frac{2}{3}$ centimetres, is—

Joints	...	...	...	20	centimetres.
Instep	...	...	...	21	,,
Heel ...	...	...	...	31	,,
Ankle	...	...	...	20	,,
Leg (5 cms. above ankle) ...		...	...	22	,,

Irish Standard Measurement.—

	Joints.	Instep.	Heel.
Men's size 8 (11 in.).....	9 in.	$9\frac{3}{4}$ in.	$13\frac{3}{4}$ in.
Women's size 5 (10 in.) ...	$8\frac{1}{8}$,,	$8\frac{3}{4}$,,	$12\frac{3}{4}$,,

Dutch Measurements.—Women's size 36 (*Paris points*).

	3 fitt.	4 fitt.	5 fitt.
Joints	18 centimetres	19 centimetres	20 centimetres
Instep	19 ,,	$20\frac{1}{4}$,,	$21\frac{1}{2}$,,
Heel	28 ,,	29 ,,	30 ,,
Ankle	20 ,,	21 ,,	21 ,,

German Measurements.—The measures given below are for three fitting.

Length (Paris points).	Length (centimetres).	Joint.	Instep.	Heel.	Ankle.	Leg.
39	26	$21\frac{2}{3}$	23	31	21	22
45	30	$24\frac{1}{3}$	$25\frac{2}{3}$	35	$23\frac{2}{3}$	$24\frac{2}{3}$
36	24	$19\frac{1}{3}$	21	28	19	$21\frac{2}{3}$
39	26	$20\frac{2}{3}$	$22\frac{1}{3}$	30	$20\frac{1}{3}$	23
27	18	16	$17\frac{2}{3}$	23	$15\frac{2}{3}$	18
33	22	$18\frac{2}{3}$	$20\frac{1}{3}$	27	$18\frac{1}{3}$	$20\frac{2}{3}$

CHAPTER IV.

SOLE-SHAPES—LAST SECTIONS—LAST MAKING AND LAST FITTING.

The Production of Sole-Shapes is a very important operation in the making of boots and shoes. It requires a knowledge of the construction and proportion of the foot, besides a considerable degree of artistic skill. Sole-shapes may be prepared for two purposes—either to fit or suit lasts already in existence, or to provide shapes to enable lasts to be made to a particular pattern. It is to the latter purpose that the remarks of this chapter will be chiefly devoted. A sole-shape should represent the *sole-area* of a foot, and should be so constructed that it will allow, as far as possible consistent with "fashion," a free action to the functions of the foot. The difference between a *draft* or outline of the foot and a *sole-area* impression should be well understood. A *draft* is taken by passing an upright pencil round the foot, and the tracing made on the paper gives the contour of the margin of the foot; but it does not convey the actual sole-area or its dimensions. A real sole-area is that which is formed by the portion of the plantar surface that comes into contact or presses upon a flat surface. To obtain the

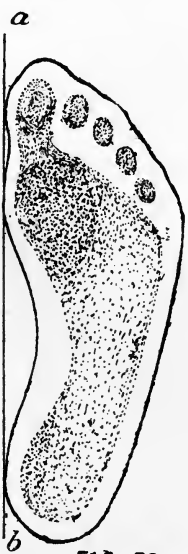


FIG 59

latter, an impression should be taken as well as the draft or plan. Fig. 59 gives an illustration of an *impression* and a *draft* of the foot. The line will show the margin of the foot (due allowance being made for the pencil used), and the dotted portion indicates the real sole-area. To ascertain the width of the sole, allowance must be made for extension of the foot when the full weight of the body is borne upon it. A sole-shape that may be correct for one position of the foot, may not suit others. The height of the heel affects considerably the shapes of soles.

Sole Proportions may be either longitudinal or transverse. The former will locate, and should be recorded the same way as lengths are taken, *i.e.* on the size-stick principle. The transverse proportions are the widths of the various located positions. The principal places of taking measurements are—the width of bottom at the joint, termed *tread;* the width of heel, called *seat;* the narrowest part of the shape, the *waist;* and the *toe.* The locations of these measurements are proportioned to the length of the sole-shape, and this numerically expressed is not identical to the expression of the *location* of similar positions in relation to the foot's entire length.

In an average *foot,* the inside joint is situated two-sevenths of the length (as measured by a size-stick) from the toe end, or, if measured from the heel, five-sevenths of the whole length from the hinder part of the foot. The *seat,* similarly, is distanced from the heel one-sixth of the *foot's* length. The *waist* is mid-way between the *tread* and *seat.*

These positions not only afford a place for regulating the *widths,* but they also indicate other important features; for instance, the *tread* marks relatively the *line of contact* of the anterior portion of the foot, which line alters its position as the heel of the foot is raised, thus enabling the fore part to be shortened *pro rata* as the heel is raised. The *seat* will mark the correct position of putting on the heel of the boot or shoe so as to give the greatest support

to the posterior region of the foot. A line perpendicularly descending from the seat should pass through the centre of the heel, and will guide the design of a heel, preventing surplus "lifting" being given, thus reducing the weight of the hinder portion of the shoe, while giving its legitimate support.

In applying these positions to a *last*, the additional length must be noted—say two and a half sizes are allowed over the length of the foot for the last. This will alter the position, in relation to the length of the *last*, of the

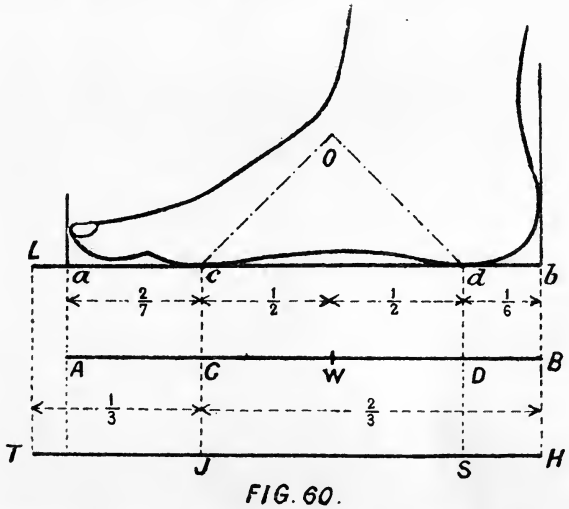


FIG. 60.

inside joint, which would be about one-third of the distance from the toe.

In the diagram No. 60 this difference is graphically shown, where *ab* indicates the length of the foot measured by the size-stick. The inside joint *c* is situated two-sevenths of the entire length *ab* from the toe end *a*. The seat *d* is one-sixth of *ab* from the heel end *b*. The dotted triangle *c*O*d* is supposed to illustrate the transmitted weight of the body. The distance between *a* and L is the addition made over the foot's length for the last-length.

The line below, ACDB, is the proportion of the sole

of the foot longitudinally related, and W is the *waist* position situated equally distant between C and D. Below this line another one is drawn, TJSH, that shows the proportions of the last; and it will be noted that the inside joint of the last is located one-third of the last-length from the toe end T.

The *width* proportions are illustrated in Fig. 61, where T equals the bottom-width, or *tread*. The line at S is

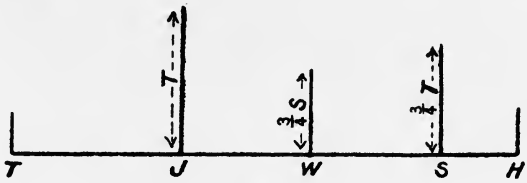


FIG. 61.

averaged at three-fourths of the tread, but is subject to variation due to the kind of last, sort of work, etc.

The *waist* W is three-fourths of the seat, but is varied according to the work, such as sewrounds, etc.

The Effect of raising the Heel of the Foot upon the marginal outline of the sole-area can be best studied by taking impressions with various height heels. The principal effects are—the change of position of the line of contact of the anterior portion of the foot, and the alteration of the line of the inside of the great toe. By "line of contact" it is understood to define the position of bearing of the fore-part of the foot, and does not necessarily mean the joint-line of the sole. In Fig. 59, which illustrates a draft and impression taken from a foot, the straight line *ab* indicates in the margin of the foot the straight inside form, and is one of the characteristics of the "Meyer"-shaped sole; but here it is not intended to show the sole, but only the upper margin or border of the foot. A foot may have a straight form or shape in this portion, and yet in the sole-area the line connecting the inside joint with the toe may incline inwards from

the line *ab*, Fig. 59. To make this clear, Fig. 62 is given, showing the sole-impression without the *draft* or *plan*, where it will be observed the line *ce* makes an angle with the line *ab*. This will give an explanation to the fact observed when sole-shapes are designed upon the Meyer principle, that, after wearing, the inside corner of the toe of the boot does not fit the toe as it is supposed to do. It also gives a reason why shoes that are designed with the inside of the fore part tapering slightly away from the line *ab*, Fig. 62, are comfortable, and do not

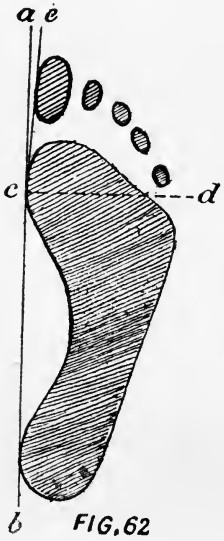


FIG. 62

FIG. 63

cause the foot to be misplaced. It must be understood, however, that in the latter fact alluded to, it is supposed that the margin of the last made to the sole-shape recedes from the feather of the last towards the line *ab*, Fig. 62. The line *cd* in Fig. 62 illustrates the line of contact for a foot with no heel.

If a block, say half-inch, is placed under the heel of the foot, the line of contact will move forwards, and it is found by experiment that it amounts to

an average of $\frac{1}{18}$ in. for each $\frac{1}{2}$ in. that the foot is raised.

A reference should now be made to the plantar view of the skeleton of the foot, p. 29, where the phalange of the great toe has a dotted line round it.

If the foot is put upon a level surface without any heel, and the great toe be raised, it will be observed that as the toe is elevated it moves *towards* the middle line of the foot XY in the skeleton. The same effect is observed if the heel is raised when the foot is upon the ground, and it may be reduced to a proportion for the amount raised.

Fig. 63 is given to illustrate this; the line E*c* showing the amount the toe has travelled away from the line AB. For each $\frac{1}{2}$ in. the heel of the foot is raised, the distance away from A is $\frac{1}{9}$ in.

Methods of constructing Sole-Shapes.—There are several well-known methods of constructing a sole-shape, and they are based upon the theories that have been advocated from time to time as to the best form of shoe. Some of these ideas, advanced chiefly by medical men, have been tested, and in practice do not give the results that should be expected. This failure is often due to the fact that the ideal shape has been designed without taking into account the full action of the foot.

Sole-Shapes to follow Camper's Theory may be produced by equally dividing the bottom-width, or *tread*, on either side of a central line that passes through the *seat*-line, so that one-half of the seat-width is on each side. The toe is thus the same for both halves of the shape. It is the principle adopted for constructing sole-shapes for "straights." Fig. 64 is an illustration of a "rights and lefts" shape upon this plan.

Sole-Shapes upon Meyer's Principle are constructed with the *inside* line from joint to toe, coinciding with the line that comes from the inside point of the heel or seat (Fig. 65, AB). It makes a peculiar twisted form, that is usually very uncomfortable to wear if the boot or shoe has a heel.

It also tends to the production of corns on the small toe, and the wrinkles that are formed in the upper leather,

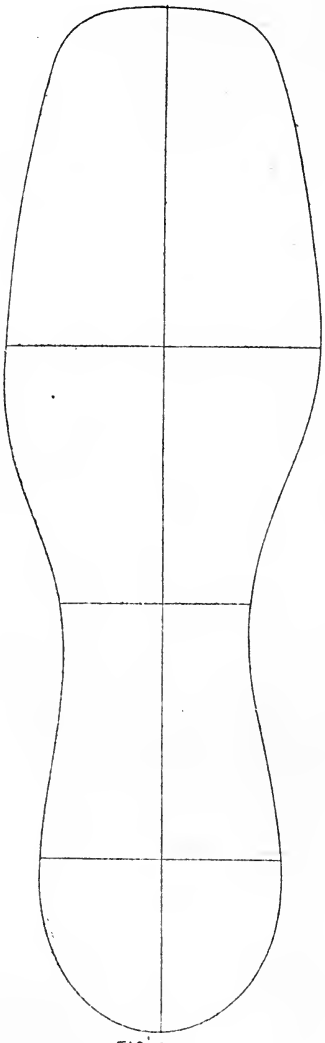


FIG 64.

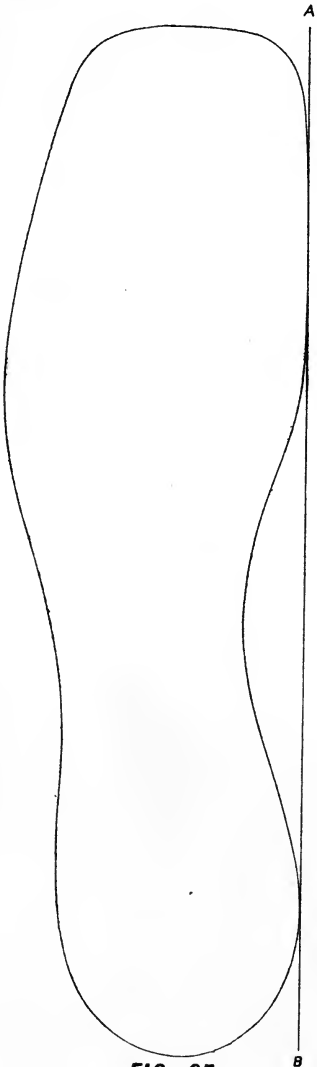


FIG. 65.

caused by the shape not conforming to the foot, abraise

the upper surface of the toes. The illustration, Fig. 66, gives an idea of a sole-shape designed upon the Meyer theory applied to a foot.

Hannibal's System of constructing a sole-shape is a more practicable one than either Camper's or Meyer's. A central line is drawn, equal in length to the size to be designed (*cd*, Fig. 67). The width of the seat is equally divided, and a portion placed on each side of the length-line *cd*. Two lines are drawn, parallel to the length-line, through *q* and *r* (the seat-width), and the parallelogram *opqr* completed (Fig. 67). The centre of the line *cd* is obtained, and the line *ab* drawn. The line *ss* is situated one-sixth of the entire length from the heel end *d*. The positions of the *outside* and *inside* joint-line are obtained by measuring 1 in. and $1\frac{3}{4}$ in. respectively above *cd*. This is only for size sevens adults', and the other sizes are obtained from this *data* by the proportion (longitudinally) that these points are in relation to the length (see Fig. 69).

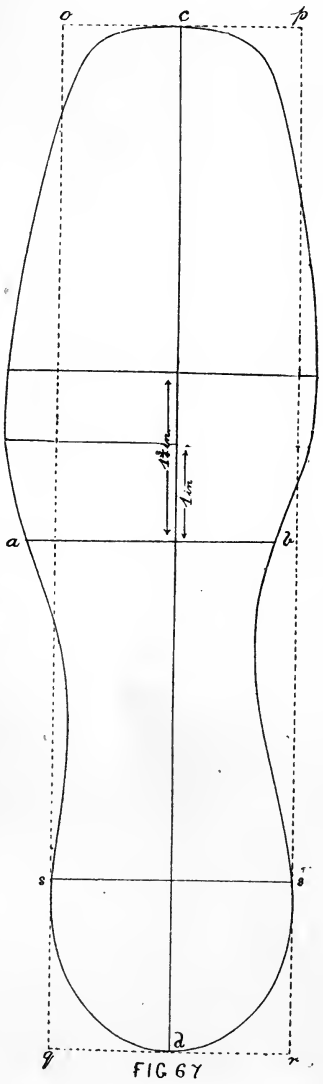
FIG. 66.

To ascertain the tread-width of the shape and its relation on either side of the line *cd*, the *seat* width is taken away from the *tread*, and the remainder divided into four equal parts, one-fourth being placed on the inside joint, and the remaining three-fourths on the outside joint. Through these points the shape has to pass, and the shape of the toe may be varied to suit the requirements of the case.

The Pass-May Method of designing a sole-shape is an extension of Hannibal's system, and the method furnishes particulars and proportions that enable a certain shape or shapes to be reproduced with a certain amount of exactness.

In Fig. 68 an illustration of a two-fitting insole-shape is given, constructed on this method. A line, AB,

is drawn, equal in length to the size required, say women's fours, *i.e.* 9⅔ in. long. Divide the seat-width into two equal parts, and mark a moiety each side, *a*, *b*. Through *ab* draw lines parallel to the central line AB. The line AB is next to be divided into six equal parts, and through the divisions thus made (1, 2, 3, 4, and 5) lines are drawn at right angles to the central line, and parallel to the lines *ab* and *cd*. The width of the seat is subtracted from the full width of the tread, and the difference divided into four equal parts (see Fig. 68, NOP).



One of the divisions is now measured from the point indicated by the line that passes through 2, towards the left-hand, and marks the position on the inside joint (see W, Fig. 68).

Below point *r* on the line *db* mark (for size 4) $\frac{3}{16}$ in. Join W*w*. On this slanting line, from W, mark off the *full width* of tread NP, and thus obtain R. Through R draw a line parallel to *db*. At a distance of $\frac{3}{8}$ in. (for size 4) from R mark M. Divide equally 3 and 4, and draw waist-line, which is to be made three-fourths of the width of seat. One-

eighteenth of the length (or one-third of A1) is to be marked from A, and a line drawn across, also one-

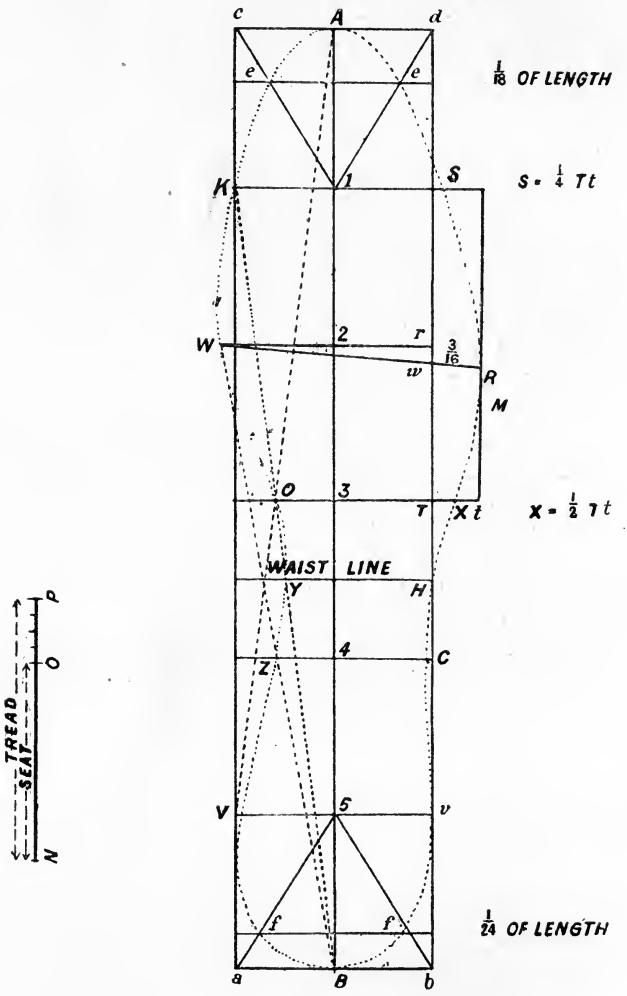


FIG. 68. LADIES FOURS TWO FITTING SHAPE

twenty-fourth of the length (or one-fourth of 5B) to be marked from B, and a line drawn. Join 1*c* and 1*d*, and

where it crosses the one-eighteenth line mark *ee*. Join 5*a* and 5*b*, and mark *ff*. Divide T*t* into two equal parts in point X, and S to be one-fourth of T*t*. With dotted lines join KB, and where it passes the line through waist, mark Y; join WB, and where it crosses the line through 4, mark Z; and join AV, and where it cuts the line through 3, mark O. To complete, join with a suitable curve the points A, *e*, S, R, M, X, H, $\frac{1}{16}$ in. inside C, *v*, $\frac{1}{16}$ in. inside *f*, B, *f*, $\frac{1}{16}$ in. inside V, Z, Y, O, W, K, *e*, A.

How to obtain Proportions for other Sizes of such measurements as the 1 in. and $1\frac{3}{4}$ in. in Hannibal's method (Fig. 67), or $\frac{3}{16}$ in. and $\frac{3}{8}$ in. in the Pass-May method (Fig. 68), and any other arbitrary measure that is measured *longi-*

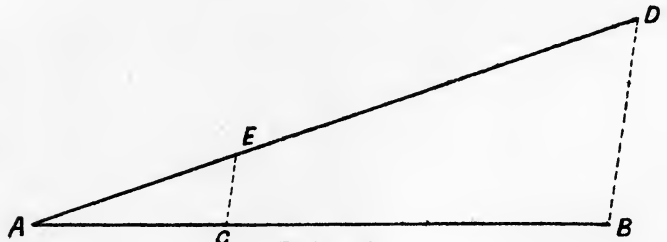


FIG. 69.

tudinally. Draw a line AB (Fig. 69) equal in length to the size that the arbitrary measure is decided upon, and from A mark off the proportions—such as 1 in., $1\frac{3}{4}$ in. (Fig. 67), $\frac{3}{16}$ in., and $\frac{3}{8}$ in. (Fig. 68)—that it is required to ascertain in some other size. Let AC denote this. Now draw a line, AD (Fig. 69), equal in length to the size whose proportion is being sought. Join DB with a dotted line, and through C, parallel to DB, draw the line CE. The AE measured from A is the required proportion.

A System of Sole-Shape Construction, based upon the Principles illustrated in Fig. 60, will conclude the description of this section. It will also show how the various shaped toes that are usually called for may be produced upon a system.

Fig. 70 illustrates the construction of a shape for

a women's size 4, fitting 2 (from the scale facing the title-page), and is given in Nos. 1, 2, and 3 toe for $1\frac{1}{2}$ in. heel.

Data used.—(*a*) The *line of contact* moves forward $\frac{1}{18}$ in. for each $\frac{1}{2}$ in. elevation of the heel of the foot; (*b*) the line from the inside joint to the toe travels inwards towards the "line of muscular action" $\frac{1}{9}$ in. for each $\frac{1}{2}$ in. elevation of the heel of the foot; (*c*) the seat is situated equally distant on either side of the central line XY; (*d*) the waist is three-fourths of the seat,* and is proportioned either side of the line XY, one-third to inside, and two-thirds to outside of the waist; (*e*) the joint-width or tread is situated on either side of the line XY in the proportion of four-ninths of the entire width to the inside, and the remainder to the outside.

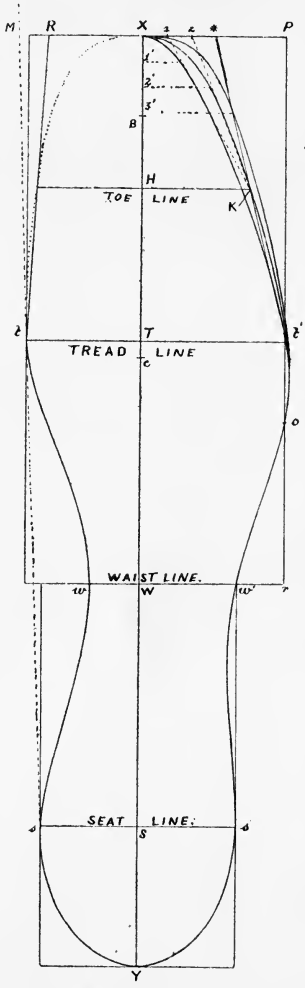


FIG. 70.

To construct. — Make a line, XY, equal in length to the size required (say $9\frac{2}{3}$ in.). From X mark off the length allowance added over the foot ($2\frac{1}{2}$ sizes), B, Fig. 70. From B measure two-sevenths of BY, and mark C. Divide BY into six equal portions, and from Y mark S.

The shape is for, say, $1\frac{1}{2}$ in. heel, therefore mark above C towards B the point T,

* This proportion varies in sewrounds, shooting-boots, etc., and must be modified to suit the kinds of work.

allowing $\frac{1}{18}$ in. for each $\frac{1}{2}$ in. heel elevation, *i.e.* $\frac{3}{18}$. To obtain W, the distance between TS is equally divided.

Through Y, S, W, T, and X draw lines at right angles to XY, and the position-lines will be obtained for *seat*, *waist*, and *tread*. The toe-line is found by taking a point midway between XT. The seat-width is equally divided, and one-half placed each side the line XY. Through *ss'* lines are drawn as far as the waist-line and parallel to XY. Four-ninths of the tread is measured from T to form the inside joint, and the remaining five-ninths from T to form the outside joint. Parallel to XY draw lines from the waist-line through *t* and *t'*, as shown in the diagram, Fig. 70. One-third of the waist-measure is marked from W towards *w*, and the remaining two-thirds put from W towards *w'*. One-third of the distance *t'r* is marked from *t'*, and point O found. A dotted line, M, is drawn from *s* through *t*. From M is measured towards X $\frac{1}{9}$ in. for each $\frac{1}{2}$ in. of heel elevation (here $\frac{3}{9}$ in.), and R marked. Join R*t*.

To obtain the toes Nos. 1, 2, or 3, divide line XP in point *. Join **t'*, and where it crosses the toe-line mark K. Divide line X* into three equal parts (1, 2, Fig. 70), and also XH into six equal parts, and number 1', 2', 3'. Join from 1 to K and from 2 to K, and through 1', 2', 3' draw lines parallel to XP, and where 1' crosses the line that is drawn from 1 to K it gives the point through which No. 1 toe will pass. Similarly, where the line 2' passes the line 2K is the point through which No. 2 toe will pass, and where 3' passes the line, *K will be the point for No. 3 toe to pass. To complete the shape, draw from X through either 1, 2, or 3 toe, towards *t'*, and thence through O towards *w'*. Bending the curve inwards, it comes to point *s'*, and then passes through Y. The other side of the shape is determined by continuing through *s*, *w*, *t*, and according to the shape toe finish at X.

Pointed or Square Toes are not always to be put on shapes because the foot is tapering or square respectively; but if the shape and last be suitably constructed in other respects the toe may be designed to suit the "fashion"

without injury to the foot. In a pointed toe, for instance, if the toe is placed, not in the centre of the tread, but opposite the second toe, and the curves from this point on either side be gradual, a comfortable boot may be produced. Fig. 71 will give an illustration of this principle, and Fig. 72 show how the foot may remain uninjured by a pointed toe.

Grading other Sizes and Fittings of sole-shapes may be done in one or two systems, and by machine. The shifting

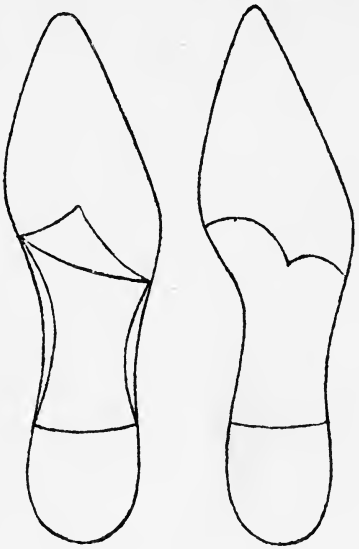


FIG. 71.

FIG. 72.

systems for a short range of sizes or fittings are very simple, but in the hands of an inexperienced person, the waists of the fittings are out of true proportion. The radial system produces grades, in the *ratio* that the several widths are to the length, and this is not what is required to suit the grade of the widths.

The Pass-May System of grading Fittings is illustrated in Fig. 73, where AB is the length-line, and CD the tread, and EF the seat-line. The amount of grade is decided

upon for the tread (see table, p. 78), say it is $\frac{1}{9}$ in. for each fitting. Following, strictly, this system, it is said one-eighteenth is required for the seat, the location from the point B being one-sixth of the entire length, and one-half of the tread location; therefore one-half the grade of the tread is advocated.*

The tread location is one-third of AB; therefore, if the grade used for fittings at the tread is $\frac{1}{9}$ in., three times this amount, viz. $\frac{1}{3}$ in., will be required to be used at the end B, so that, when shifting out to get the line from the toe A to D, or A to C, the required grade, $\frac{1}{9}$ in., may be obtained at CD. Adhering to the system, it is advocated that one-half† of this, viz. $\frac{1}{6}$ in., is to be placed on both sides of AB, at point B. This will give *ab*.

This amount is repeated at point A, and *cd* is indicated—this will give the seat-grade as $\frac{1}{18}$ in.

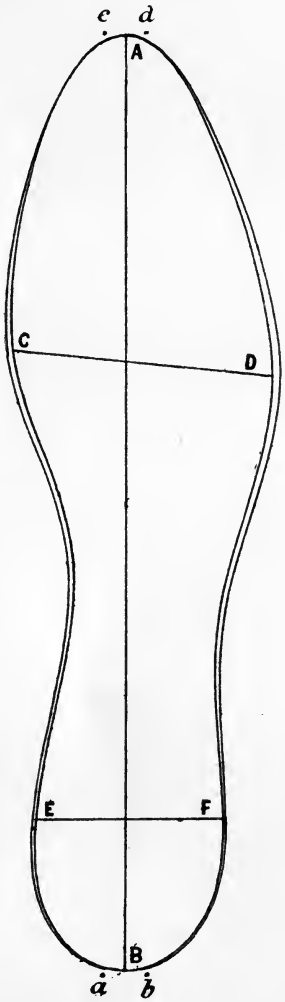


FIG. 73.

* This, however, is not correct. The ratio of EF to CD in width is what governs the grade; and suppose EF were made three-fourths of CD, then three-fourths of the grade added to CD would be required for EF.

† It should be noted this would only be *correct* when the shape graded has one-half of the tread-line equidistant of the central line AB; otherwise the amount (in this case $\frac{1}{3}$ in.) should be divided in the same proportion as the tread, and placed with the larger portion of the grade towards *b*, and the lesser towards *a*, so that the tread may be increased in correct proportion.

(If the *correct* proportion of the seat-grade is required, the grade should be multiplied by the ratio of the location of the seat to the whole length, and this product equally divided one moiety, being placed on each side of A.)

To obtain the curve at seat FB, for the fitting larger, place directly over the marked-out shape (Fig. 73) the cut-out shape, so that the lines of tread, seat, and length of both the pattern and tracing coincide. When in this position, move the central line on the pattern towards *d*, keeping B of pattern and tracing level. Mark from F to B. Next return the central line of pattern to the line AB of tracing, and move the pattern towards *c*, so that the central line of pattern and *c* coincides, while the point B on the pattern and tracing remain together. Trace EB, and the seat of a fitting larger than the pattern will be outlined. To obtain the curves AD and AC, place the pattern over the tracing so that length, tread, and seat-lines of the pattern and tracing are identical in position. Move B on the pattern (while keeping A in place) towards *b*, and mark the curve from A to D. Return the pattern at B, from *b* to *a*—keeping A of pattern directly over A of tracing—and mark the curve from A to C. To construct the waist-curve on this system, place the pattern and tracing level at tread and seat-lines, and then move the waist-curve, for the outside waist, towards DF, and trace the outline. This repeated for the other side gives the inside waist-curve CE.

A System of Grading, to be accurate, should not only give the total grade at a width, but should divide it in the same proportion as the ratio of the inside and outside of the pattern, so that the original proportion and shape may be preserved throughout the series. A system that answers to these requirements (based upon the principle shown in Fig. 70) is illustrated in Fig. 74. The principle of scaling fittings and sizes consists of adding the required grade in the same proportions and locations as existing in the original; and the test of the accuracy of this

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principle lies in the fact that independently constructed fittings and sizes will be the same as those scaled.

Application.—The main lines—length, tread, seat, waist, and toe—are extended on the tracing of the original shape to be graded. Then — preferably by means of a proportional compass—the increases or grades are divided and placed on the extended line. To do this, take the compasses, and span with the long leg the whole width of, say, the tread; and then adjust the nut by trial, until the small legs exactly span, say, the inside half of the tread. This will give the ratio of *t*T (Fig. 74) to the whole tread-width *t*X. The screw of the proportional compass will now be tightly fixed, and if the original shape be constructed upon the system illustrated in Fig. 70, the ratio will be *t*T equals four-ninths of *t*X (Fig. 74). Without readjusting the compass, span with the long legs the whole distance of the tread-width about to be graded, and with the small legs from T (Fig. 74) mark the inside-joint position *t'* of a fitting larger. Keeping the *same* distance in the compass, with the long legs place one point on the newly marked point *t'*, and in the direction of the outside

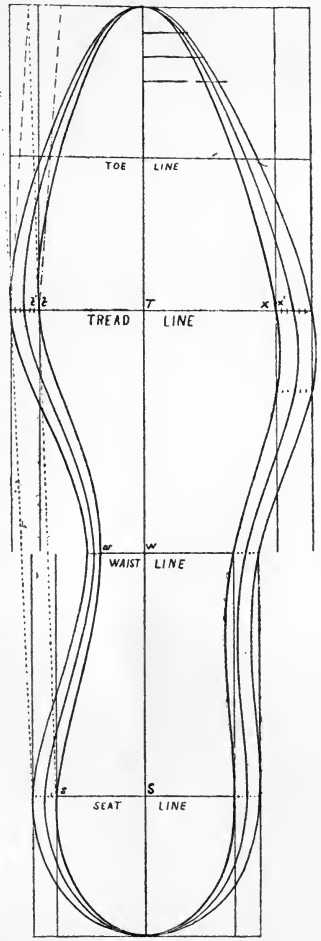

FIG. 74.

SHEWING FITTINGS 0 TO 6 GRADED WITH THE 0, 3, AND 6 OUTLINED No 1 TOE.

joint mark the full width of the fitting greater, and thus indicate the outside joint X′. If not working to a scale of measurements for seat-width, the grade of this line may be obtained by again setting the proportional compasses so that in the long legs the whole width of the original tread is spanned, while the smaller legs span the original seat (or more easily applied, half the seat). Then, while the compasses are at this ratio, span with the long legs the whole tread of the new fitting to be constructed, and the small legs will give the whole seat of the new fitting (or if the half-seat was spanned in the original, the half-seat of the new fitting will be obtained, and can be marked both sides of S, thus saving the division). If working to a *scale* of seat-widths, the measure may be transferred direct.

To obtain the waist, or any other part, proceed in the same way. For instance, span in the long legs half the seat *s*S (Fig. 74), and with the short legs the distance of the width W*w*. Then fix the nut of the compass. With the compass in this ratio, span with the long legs the *new* half-seat measure, and the short legs will indicate, measured from W, the inside half of the new waist measure. In the Fig. 74 the shapes of No. 1 toe have been outlined for 0, 3, and 6 fittings, showing the method of obtaining the same shape by grade and construction.

Cotê Grading Machine is called by the inventor "the Improved Pantograph," and is an improvement that enables patterns to be produced which have not the defect of a proportional width-grading to the length, that would be produced by the ordinary pantograph. It is a simple machine to operate, and in its latest form it will produce correct shapes of patterns. The machine is illustrated in Fig. 75, and it will be observed to consist of a cast-iron frame, containing in the base a sheet of plate-glass. The handles A, A are arranged so that it will raise the bars B, B, in which slide the movable bars C, C. When this is raised, it allows the paper or board to be placed in position for cutting, and, when lowered, the bars hold the paper

firmly to the glass, preventing any sliding. The graduated arms A, B, C (Fig. 76) are used to regulate the length of the patterns, and in use require to be adjusted to the same figure on each arm. The width is regulated by the nut

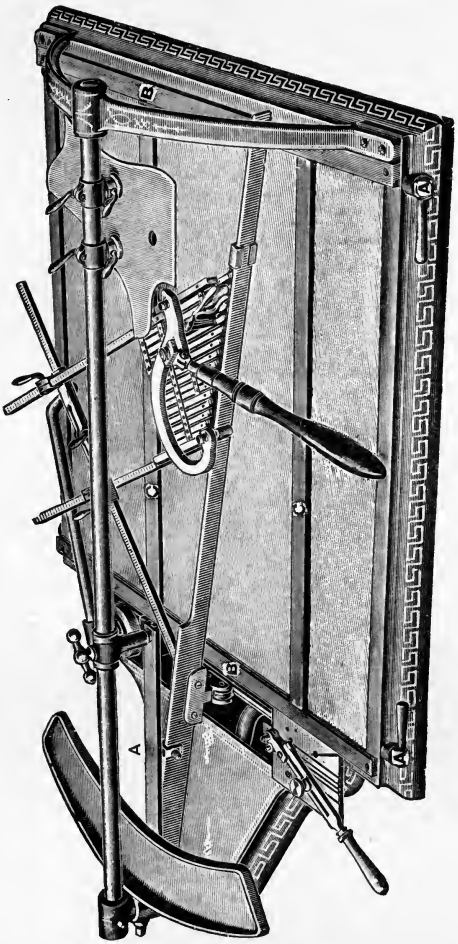

FIG. 75. COTÊ GRADING MACHINE.

D, which slides along the scale either side of zero. Above the handle in Fig. 75 is a grooved wheel that is free to turn on its centre. It is situated over the hole J in Fig. 76, and when the little revolving knife is placed in J, a

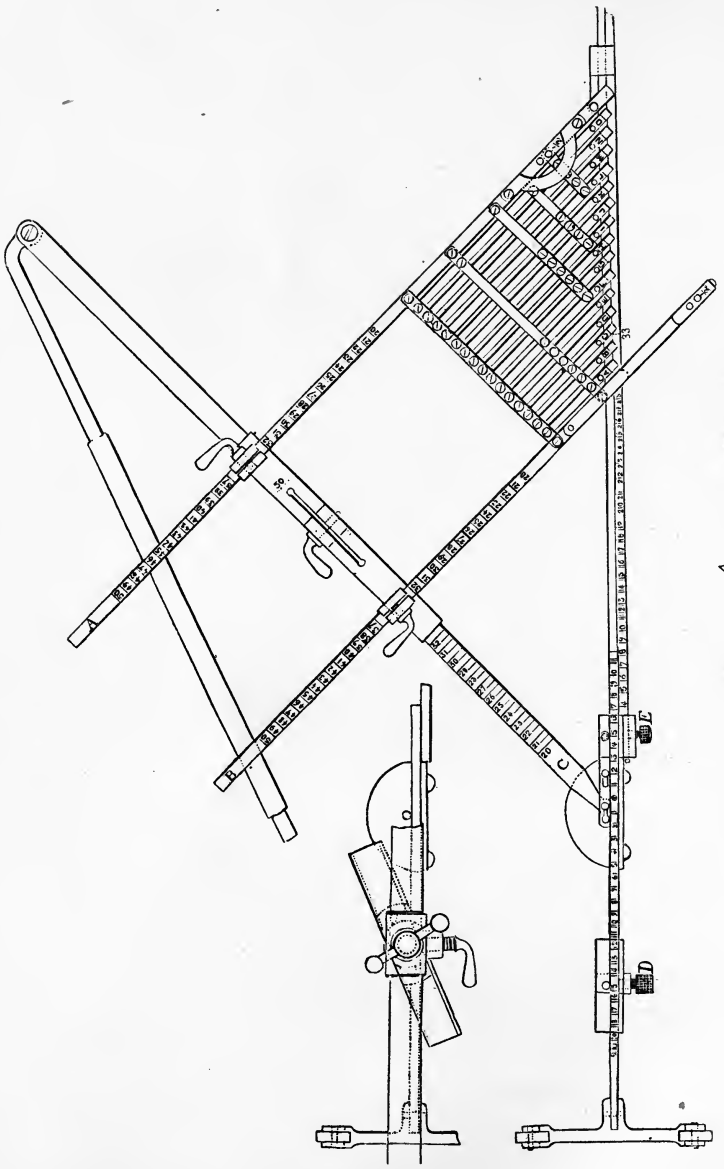

FIG. 76. PLAN OF COTÉ GRADING MACHINE.

pattern—the same size as the one used for a standard—is cut out. One hole above, *i.e.* K, gives one size larger, and a hole below, *i.e.* I, a size smaller.

To use the machine for cutting sole-shapes in sizes, measure the length of the standard-shape by the rule * provided. Supposing it is size 7's men's, it would measure 32. The machine is set to 32 at A, B, and C (Fig. 76), and will enable it to produce patterns differing in length by sizes, *i.e.* $\frac{1}{3}$ in. The unit of grade-width is now to be decided—for sake of illustration, say $\frac{1}{12}$ in. between tread and tread per size. The total width of the tread is measured, say 3 ins., this would measure thirty-six one-twelfths of an inch. Subtract the length from the width, thus—

Length	36	units.
Width	32	„
Difference	4	„

The screw D is moved to the *left* hand of zero four units, and the machine is adjusted ready for use. When the *length* exceeds the width, the screw D is put to the *left;* and when the width exceeds the length, the screw is placed to the right hand of zero.

Last Sections, or breech patterns, are sometimes made so that a particular idea may be produced. They must be accurately cut, and, if made for several sizes, should be correctly graded or scaled. In Fig. 77 a longitudinal *breech* pattern is illustrated, and is so cut that it will allow a last to pass through it lengthways, just touching it equally all round. This would ensure a correct *pitch* and *spring* being obtained, and if the positions of measuring the *joints* and *insteps* of the last were marked, it would enable the girths to be taken in the correct positions. Fig. 78 illustrates a cross section, or *breech*, taken at the joints.

* This is a rule divided into one-thirds of an inch, and numbered from the end consecutively without a break. It is sub-divided into one-tenths.

The insole shapes, if they are prepared for last-making, must be accurately graded, so as to preserve the initial

FIG 77

shape, and yet be adapted to the measurements required by trade custom. This is illustrated by Fig. 79.

The Woods used for Last-Making in England are principally *beech* and *charme*. Beech in nature and quality depends a great deal upon the soil where it is grown, and upon the rapidity of its development. The trunks of small trees, or the branches of the larger ones are chiefly used for last-making. The thickness of the bark is, as a rule, a guide as to the quality of the wood—the thicker the bark the better the timber.

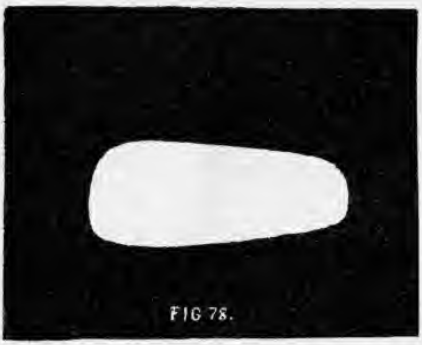

FIG 78.

Charme, or French wood, is imported into this country in blocks, roughly shaped. They are thus called chopped blocks. The wood is of the hornbeam family, and is close in the grain, hard, and usually very free from knots.

In selecting a suitable wood, the chief points to be

observed in making a choice are: a clean cutting wood free from knots, non-liability to split, hardness of texture, smooth grained, and not hygroscopic.

Structure of Wood.—The woods used for last-making grow from the outside—that is to say, the new wood is formed between the old wood and the bark. The newly produced wood is softer than the older wood, and in drying shrinks most. The old wood is termed *heart*-wood, and the new, *sap*-wood. Each season's growth of the tree may be distinguished by the markings of rings that in a section of a trunk would be concentric (Fig. 80). These rings are termed annular rings, and the number of them gives the age of the tree. In the illustration (Fig. 80) it will be noticed that there are other marks besides the concentric rings, and that they radiate from the centre, or pith, and form the radii to the circumference of the tree-section. These lines are termed *medullary* rays. As the timber dries or shrinks the direction of the shrinkage will be indicated by the annular rings, and in the "cracks" illustrated in Fig. 80 it should be noticed that the shrinkage is greater nearer the bark than at the centre or pith. This fact will have an important bearing upon the way the wood is cut into lasts.

FIG 79.

Spokes are the triangular pieces of wood, sawn from the trunks or boughs. They are usually either cut into lengths 36 to 40 ins., or into smaller sections about 12 ins. long. Fig. 81 illustrates the former, and would provide timber for three lasts. There are three or four such wedge-

shaped pieces to the length cut from the trunk, according to the size of the tree.

Seasoning the wood is an important operation in the preparing of the wood for last-making. The *spokes* are stacked in a dry, airy place, free from direct sunshine or heat, for a period of about two years at least. The imported blocks do not usually get such a lengthy drying, as they are supposed to be partially seasoned when received. With green wood, steaming is sometimes resorted to, being a shorter process and advocated because it prevents shrinkage. This steaming changes the colour of the wood, and makes it a little softer. The seasoning by exposure to the air seems to retain more of the nature of the wood.

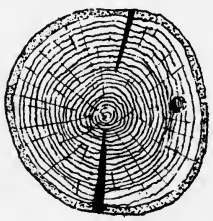

FIG. 80.

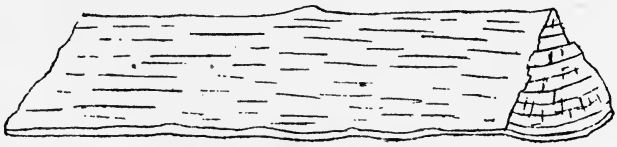

FIG. 81.

If the timber has been cut into 36-in. lengths the spokes will be first cut into three, and afterwards sorted into pairs.

Sorting into Pairs.—From what has been said respecting the structure of wood it will be seen that wood can be chosen to make lasts so that the greater shrinkage may be either in the last's height or width. This is an important point, because, if the wood should shrink much, odd lasts would be the result, whereas, if properly mated, the shrinkage could be made good by "fittings."

Bark-bottomed lasts are those which are selected so that the bottoms face the bark, and bark sides are those that are cut from the wood so that the "height" of the last runs parallel to the bark. Bark sides are usually preferred, because any shrinkage that takes place may be

remedied by using a fitting on the top of the last. Figs. 91, 92, 93 show bark-sided lasts, and Figs. 90, 94 bark-bottomed lasts.

Chopping or sawing the Block is the next process performed. The older plan was to chop the block with the axe, while latterly it is sawn with the circular saw into something like the shape required. This "squaring" of the block greatly facilitates the after work of knifing (Fig. 82).

FIG. 82.

Knifing the block is the next stage. It is done with a *bench knife* that consists of a blade about 14 ins. long. A series of well-directed cuts from this knife gradually diminishing in size reduces the block to the rough outline of the last. During the *knifing* constant reference has to be made to the insole shape or model, and the measuring tape has to be frequently applied to the evolving last. The roughed piece is now ready to have the block cut.

The block is sawn down according to the kind of work required to be made upon the last, or the taste of the last-maker.

The Completing Processes are drilling the holes to allow the block and last to be drawn respectively from the boot, rasping, scraping, and finishing. These operations require attention, as they add much to the shape, finish, and after use of the last.

Last-Making Machinery.—The machines for turning lasts are chiefly of two kinds—one, the copying lathe, that copies from a pattern last a similar sized one; and the other sort are accurately constructed machines, that enable the other sizes in a "set" to be turned from one model. The degree of accuracy with which this is done is surprising—the correct pitch, spring, and shape is preserved throughout the set. An illustration of a machine of the latter type is given in Fig. 83. A block as it leaves this

machine is illustrated by Fig. 84. The other machines used are band saws, drilling machines, finishing machines, etc.

Lasts may be either "rights and lefts" or "straights." When they are made so that they are symmetrical on either side of a last, they are "straights;" but when made

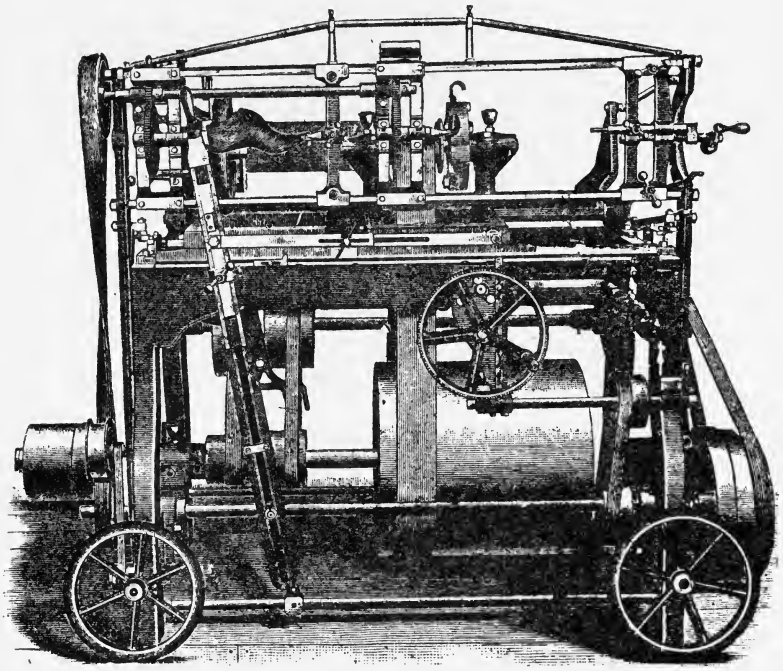

FIG. 83. GILMAN'S LAST TURNING MACHINE

with an outside and inside joint they are "rights and lefts."

Pitch is given to a last to accommodate the heel of the boot or shoe to be made thereon. It is the elevation of the back portion of the last from the line that would pass tangentially through the position of the joint. As the height of the heel is increased so the *pitch* is made greater, and following, the waist is hollowed more to facilitate the

building of a square heel. In Figs. 90, 91 the amount of elevation of the seat of the last above the line below is the pitch P.

Spring is the term used to denote the elevation of the toe of the last from the line that would pass through the joint basis S in Figs. 90 and 91. It is regulated by the kind of boot and firmness of the sole. If the substance of the sole be light, very little spring is required, if other things are equal; and on the other hand, stout soles require a greater amount of spring in the last. The reason for this is because, if spring is not provided in the stouter goods, the boots when worn will "turn up at the toes" and, as a consequence, wrinkles will be formed across the front of the shoe which are unsightly and uncomfortable.

FIG. 84.

The spring for an average last would be about $\frac{1}{2}$ in.; a shoe last having another $\frac{1}{8}$ in. A scale of "last spring" may be constructed, and for convenience may be measured from the level surface upon which rests the last, the seat not being raised. The basis for such a scale would be, men's, 1 in., and would be subdivided upon the plan illustrated in Fig. 58.

Other than the spring actually required for the material and substance of the boot, there is an allowance made for the fact that in high heels the "line of contact" is more forward, and consequently the fore part of the shoe is relatively shorter, preventing the full elasticity and bending of the foot. A high-heeled boot—such as a Louis—does not need so great a spring in this sense as a boot with a low walking heel. The rule may be condensed thus—

Low heels—longer forepart—more spring.
High „ shorter „ less „

Sometimes the term "spring" is used to describe the hollowness or arch of the waist, the term "dead" being applied when the waist is flat.

Drop, or Dead Waists are the terms used relatively to denote the style of waist of the last. If the last be placed on a stand so that the bottom is uppermost, then by placing a straight edge from tread to seat, a last would be said to be *drop* waist when the distance between the straight-edge and last is great, and on the other hand *dead* when near to the edge. The correct shape of the waist is important; first, because of the building of the heel, and secondly, to enable a correct fit to be obtained across the heel of the boot.

The Classifying of Lasts may be done in several ways, according to the kind—as block, sectional, etc.; or as boot,

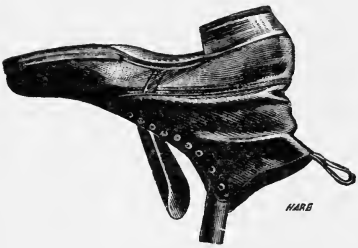

FIG. 85.

FIG. 85a.

shoe, etc.; or as machine-sewn, welted, hand-sewn, etc. The former is preferable, as the others may be classed as subdivisions.

Comb Lasts are lasts made all in one piece, without having any block cut. They are used for making "needle and thread" work, sewrounds, and slippers, and during use the place of the usual block is taken by a "fitting" or "shover."

Block Lasts are lasts that have a block cut so as to permit of the last being drawn from the boot. Blocks are cut in various shapes, according to taste or work; but the ideal cut is one that allows of its withdrawal and insertion with as little tendency to injury to the goods being made as possible.

Sectional Lasts are of various patterns, many of which are protected by patents. Their use is intended to mitigate the risks from breakages and alteration of shape of the goods during manufacture, and the principle is to be recommended as a correct one. See Fig. 85, 85*a*.

The *Easy Exit* last is a well-known device of this sort, and is illustrated by Fig. 85*b*. The last is in two portions, which are locked by a spring that is released by a key. The men's lasts sometimes have a block as well.

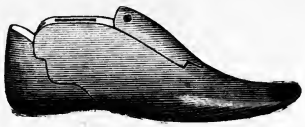

FIG. 85*b*.

The *Arnold* hinged last is another variety of sectional

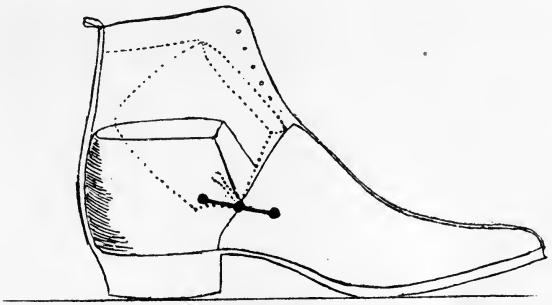

FIG. 86

last, and is illustrated by Fig. 86. It requires no key and has no loose parts that may be misplaced.

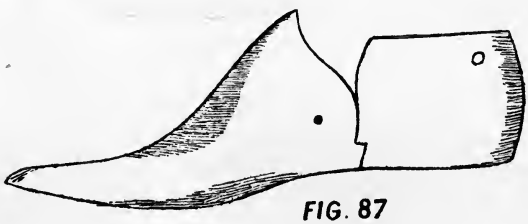

FIG. 87

The *Miller* last is illustrated by Figs. 87 and 88. It

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is a neat and compact arrangement requiring no key to loosen it.

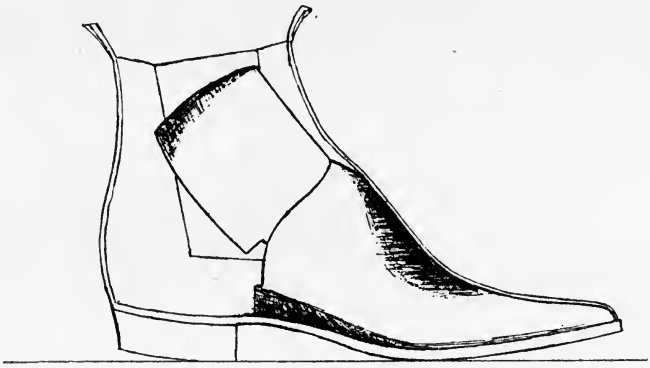

FIG 88

The *Brining* last is illustrated by Fig. 89. It consists of two portions fastened together by a cord, one end of which raises a spring. In the iron lasts the top of the

FIG. 89

spring is liable to catch in the upper during withdrawal. If this were remedied it would be a serviceable last.*

Boot Lasts are made much thicker at the sides than other lasts, and are thus made to accommodate the extra thickness required for ankle bones. As they are usually required

* Since the above was written the last has been considerably improved, and the new make is highly recommended.

for higher heels than shoes, the waists are more arched. The seat is usually, in English-made lasts, more square than necessary for a good fit—this squareness being the outcome of a desire to ease the process of heel building. Fig. 90

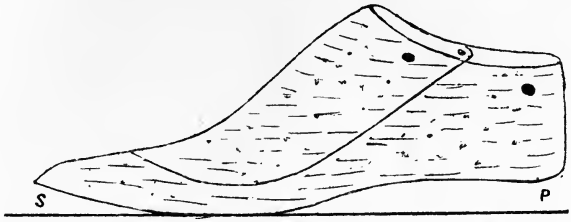

FIG. 90. BEVEL TOE. BOOT LAST

illustrates a boot last. Riding-boot lasts have a flatter waist, less spring, and higher instep than ordinary walking-boot lasts.

Shoe Lasts are illustrated by Fig. 91. They are flatter in the waist than boot lasts, and have a greater spring in the toe. The sides are thinner, corresponding to the thinness of the foot *below* the ankle bones. The outside

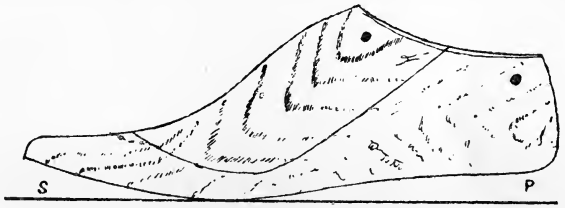

FIG 91 PUFF TOE SHOE LAST

waist is fuller than is usually made for boot lasts. Very often the line of contact is placed a little nearer the seat to assist the "clipping" of the shoe quarters when the weight of the body is brought to bear upon the shoe. The instep measurement is a little less than a boot last, say $\frac{1}{8}$ in. The bottom of the last is more rounded. Shoe lasts more nearly approach the shape of the foot than the ordinary boot lasts.

Slipper Lasts are more sprung in the toe than either shoe or boot lasts. This is rendered necessary by the

lowness of the heel usually worn, coupled with the long quarters, that have a greater tendency to lie loose or gape at the sides; and to counteract this more spring is given.

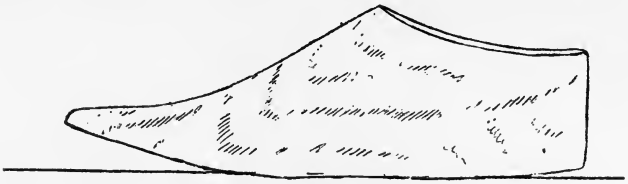

FIG. 92

The bottom is more rounded from side to side, and the waist is much straighter or more dead than in a shoe last. The sides are also thin. Fig. 92 is a slipper-comb-last, and has about one inch spring in the toe.

Lasts for making Various Kinds of Work have many minor variations that are used to suit the particular method of manufacture. Fig. 93 shows the bottom of a last that may be used for hand-sewn, sewrounds, pegged

FIG. 93.

or braced work. Fig. 94 shows a last with a metal heel-plate, for use in making welted work with a nailed heel.

FIG. 94.

Fig. 95 shows a metal-plated bottom for making machine-sewn work. Lasts for making sewrounds should be a little smaller in girth than for other work, owing to the fact that they are made inside out, and afterwards turned.

Court-shoe lasts should be flat and broad in the waist, and snugger in fitting. Lasts for finishing are slightly smaller than those upon which the goods are made, and in some cases are made higher and thinner, so as to draw away the upper from the feather. Wood lasts if varnished* or polished are more easily kept clean, and do not shrink so much. By mixing a colouring matter with the shellac various colours may be used for various kinds.

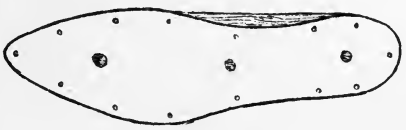

FIG. 95.

The Positions to measure Girth in a last, such as joints, instep, heel, tread, seat, etc., ought to be relatively fixed; and with the Gilman last-making machine may be easily marked by driving a round-headed nail on the top of the last where the measurements are taken. Usually the positions are a matter of judgment. The proportions that are supposed to be the basis of a table of *position* measures are, that the joints are one-third, and the instep one-half

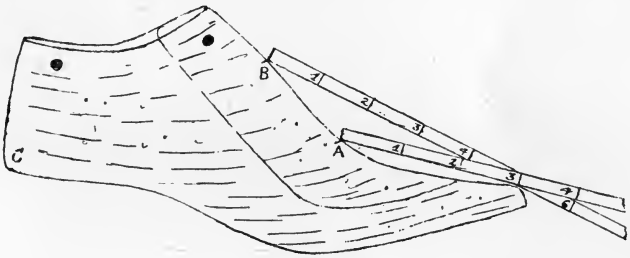

FIG. 96

of the length of the last. These are applied to the last by measuring from the toe end straight to the joint or instep position (see Fig. 96), whereas the proportions given are longitudinal ratios. Fig. 97 is drawn to illustrate the difference, where AB is the length of the last as recorded

* A varnish made by dissolving shellac in methylated spirit answers well for this purpose. If pads are used, add a little linseed oil.

by shoe sizes; A*a* the joint, taken at one-third of the entire length AB; A*b* the instep, taken at one-half AB; from X to J (not following the bend of the last) gives the joint position as usually measured on this plan; while X to I gives the instep location. It will be observed that XI is greater than A*b*, and so the figures used as given in the table below do not correspond exactly to the data it is supposed to be based upon.

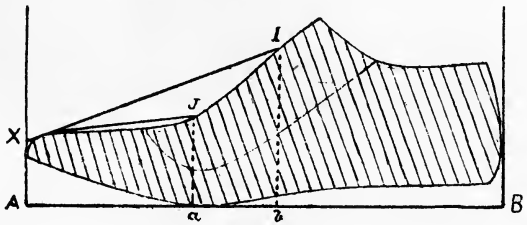

FIG. 97.

The table gives the distances from the top of the *puff* to the joint and instep respectively as XJ and XI in Fig. 97.

Sizes.	Inches.	Joints.	Instep.
1	$4\frac{1}{3}$	$1\frac{1}{9}$	$2\frac{1}{6}$
2	$4\frac{2}{3}$	$1\frac{2}{9}$	$2\frac{1}{3}$
3	5	$1\frac{1}{3}$	$2\frac{1}{2}$
4	$5\frac{1}{3}$	$1\frac{4}{9}$	$2\frac{2}{3}$
5	$5\frac{2}{3}$	$1\frac{5}{9}$	$2\frac{5}{6}$
6	6	$1\frac{2}{3}$	3
7	$6\frac{1}{3}$	$1\frac{7}{9}$	$3\frac{1}{6}$
8	$6\frac{2}{3}$	$1\frac{8}{9}$	$3\frac{1}{3}$
9	7	2	$3\frac{1}{2}$
10	$7\frac{1}{3}$	$2\frac{1}{9}$	$3\frac{2}{3}$
11	$7\frac{2}{3}$	$2\frac{2}{9}$	$3\frac{5}{6}$
12	8	$2\frac{1}{3}$	4
13	$8\frac{1}{3}$	$2\frac{4}{9}$	$4\frac{1}{6}$
1	$8\frac{2}{3}$	$2\frac{5}{9}$	$4\frac{1}{3}$
2	9	$2\frac{2}{3}$	$4\frac{1}{2}$
3	$9\frac{1}{3}$	$2\frac{7}{9}$	$4\frac{2}{3}$
4	$9\frac{2}{3}$	$2\frac{8}{9}$	$4\frac{5}{6}$
5	10	3	5
6	$10\frac{1}{3}$	$3\frac{1}{9}$	$5\frac{1}{6}$
7	$10\frac{2}{3}$	$3\frac{2}{9}$	$5\frac{1}{3}$
8	11	$3\frac{1}{3}$	$5\frac{1}{2}$
9	$11\frac{1}{3}$	$3\frac{4}{9}$	$5\frac{2}{3}$
10	$11\frac{2}{3}$	$3\frac{5}{9}$	$5\frac{5}{6}$

The Stanley Last-Measuring Machine is devised to indicate automatically the girths of lasts, and the illustration (Fig. 98) shows the machine taking toe, joint, waist, and instep measure.

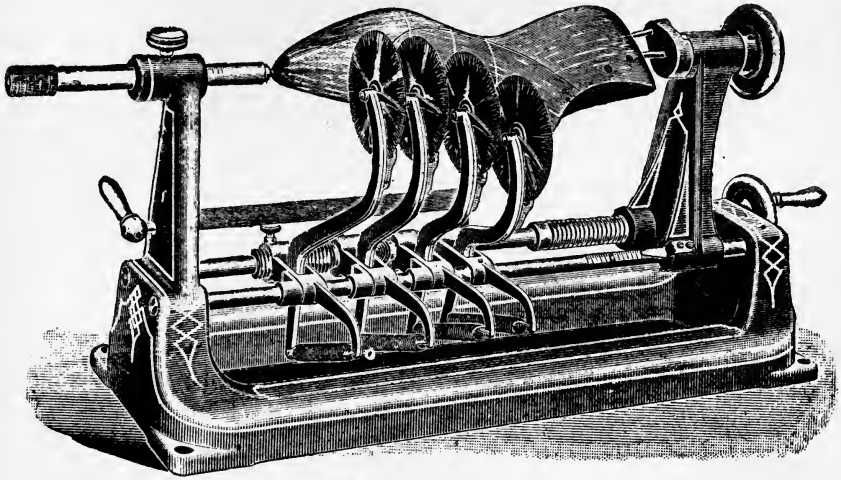

FIG. 98. LAST MEASURING MACHINE.

General Observations on Lasts.—Great care should be exercised, in getting out the original or standard model, that plenty of room is given in the correct place, and that the shape should conform to the requirements of the foot for the purpose that the last is being made. For instance, the thickness of the ball of the great toe should be provided for, also the toes of lasts should be thick enough to allow toe room.

The models for machine turning only require one foot of one size, and models for casting iron lasts should have some allowance made for the contraction of the hot iron. An ideal-shaped last should be of the right shape adaptable to the purpose of the particular boot to be made therefrom, and snug enough to confine the foot without any uneasy experience to the wearer. It should allow of an easy entrance to be made to the boot, keeping the foot in a healthy position. No injurious pressure should be in the boot made from the last, and no wrinkles of loose

leather at any part. It should be graceful and easy, and combine a skill and knowledge that is obtained by a long, studious experience.

The errors that are often found in lasts are that the backs are often made too straight, and do not conform to the back of the foot. Seats are made too square and flat, and in iron lasts are often too large. The seats should be rounded and convex, as seen by Figs. 91 and 98*a* in contrast

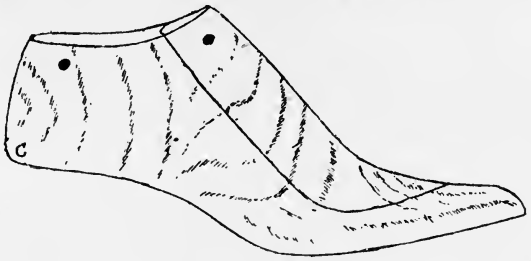

FIG. 98*a*

to 96 and 92. The arch of the waist of lasts used in factories is often too much hollowed on the outside. In shoe lasts the foreparts are often made too short, causing the toe to turn up in wear and the quarters to gape. Proper allowance in length should be made for pointed-toed lasts over those of squarer shape. The style of toe should be carefully formed, whether bevel (Fig. 90) or puff (Fig. 91), so as to give proper thickness to the toes that lie a little distance from the extreme end.

The Fitting up of Lasts requires much care and knowledge, if a good-fitting article is required. The measures, draft, etc., if taken by a different person than the last-fitter, should be carefully studied before selecting a last. In the selection of a suitable last for making bespoke, much judgment is needed, so that the last may not only conform in measurement but also in shape. The spring, style of toe, and *tout ensemble* must be such as the foot requires. Fig. 99 illustrates where the fittings should be placed to correspond with the draft. The plain outline is the draft, the dotted line the last, and the shaded portion the fittings.

Fittings are made of leather, and fixed to the last to increase its dimensions and contour. They should be so skived that when placed in position there are no sudden "ridges," but the increase should be gradual. Gutta-percha is used for affixing to iron lasts. The usual fittings are named according to the position of fixing, such as joint

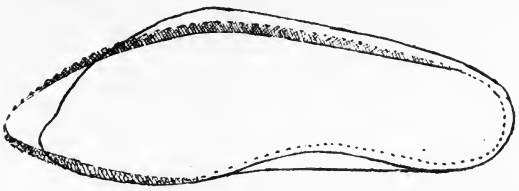

FIG. 99.

and instep fitting, or shover, joint fitting, instep fitting, heel pin, toe pin, etc. In fixing upon the girths to be made $\frac{1}{8}$ in. is usually deducted from the measure for the instep, if the foot be "bony," while the joints are full up to measure. In a "fleshy" foot $\frac{1}{8}$ in. less than the joint, and $\frac{1}{4}$ in. less than the instep measures would be made. The illustration (Fig.

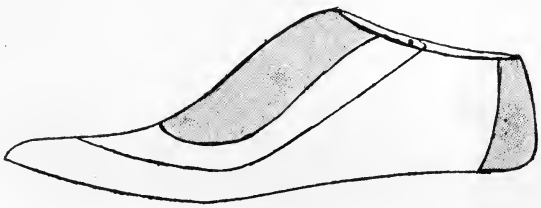

FIG. 100

100) shows a last with an instep fitting and a heel-pin. Plaster casts of a foot and a worn-out boot will give many lessons to a careful observer on the art of fitting up. The fittings are sometimes simply placed, without consideration, to make up bulk. If the joint-measure be too small, a fitting is placed on top or on the outside joint to make it to the measurement, whereas the fitting may be required by thickness and roundness of the big toe joint. This fact will repay careful study, as allowing for the proper disposition of the joint measurements, providing the last is

correct in other respects, will enable a neat fitting and comfortable shoe to be made *that will not tread over*. In Fig. 101, A is the section at the instep of a last that was

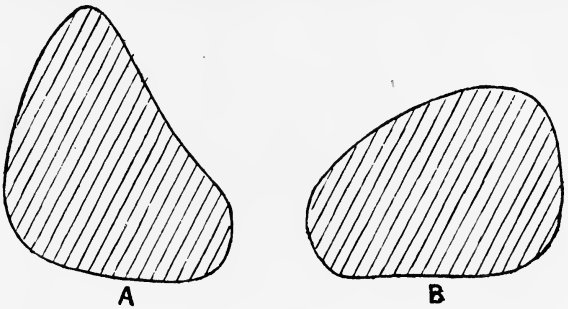

FIG 101

used by a bespoke maker to make "specials" for a foot, a section of the cast of which is shown at Fig. 101, B. The sections of the same last and cast, measured *longi-*

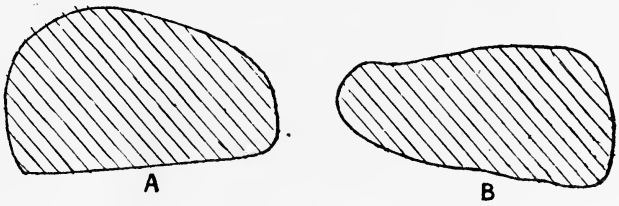

FIG 102

tudinally from the heel in identical position for the joint, is given in Fig. 102 A and Fig. 102 B for the last and cast respectively.

A well-fitted last should conform to the contour of the sole of the foot, and reproduce artistically the fundamental protuberances and hollows, and where prominent the ridge on the inside of the last should be gracefully continued to the toe, and the toes of the last will be thick enough in the right place to allow of the placing of the toes of the foot in the proper position. Lumps and dents should find no place in a fitted last, everything should be gracefully rounded and correctly positioned.

CHAPTER V.

PATTERN-MAKING AND GRADING.

THE art of pattern-cutting requires much skill, sound judgment, anticipating thought, a knowledge of the rules and principles of shoemaking, and, above all, a cultivated style and natural taste. The science, consisting of rules, measurements, proportions, methods, etc., is of little practical value without artistic abilities to execute the work. The various ways of producing patterns are so different, and the productions so unlike each other, that many must perforce be incorrect. Pattern-making is a branch of the industry that repays, more than any other, a careful theoretical study. A certainty of fit should be the ambition of every cutter, and not a reliance upon comparisons with other patterns.

The aim of a pattern-cutter should be to produce a boot which, when removed from the last, looks as though the last was still there, and it should conform to the last in little details—the lighter the material of the boot the more snugly it should fit. This is not so easy as it would at first sight appear. The various curves in a last in different directions, that have to be fitted with a flat material possessing "stretch," requires not a little care and thought. The pattern is flat, while the leg and foot are rounded, so that when the *curves* on the flat pattern are in position, bent to the leg and foot, they are altered in appearance.

Pattern-Making may be divided into sections, for convenience of description. The production of the portion

to fit the last may be termed *forme* * cutting; adding to the *forme* the remaining parts to complete the pattern that may be used to obtain the parts from which to cut the leather may for distinction be termed *standard* construction; and scaling the other patterns from the *standard* to complete a "set" classed as *grading*. The production of a new shape, or the modifying of an old style, may be termed *designing*. Long work, or cutting patterns for wellingtons, jockeys, etc., is another division.

Forme-Cutting by Soule's System.—This is the simplest and most mechanical method of cutting a forme. It was

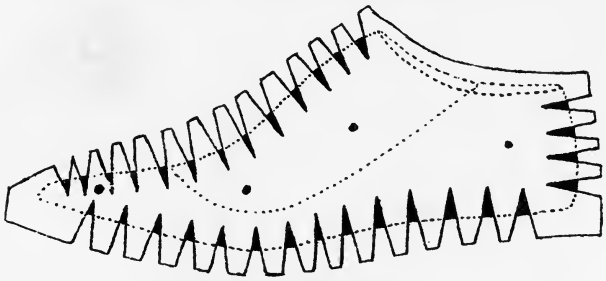

FIG. 103

first published in 1884. Since then it has been improved in detail, and the illustration (Fig. 103) will show the principal process. The *modus operandi* is as follows. The last for which the forme is required is taken and a mark made in the centre of the last on the top of the toe, and at the instep. These two points are connected by using a flexible rule, strip of card, or a sketched lead-pencil line. The back of the last is similarly divided by a straight line. Two pieces of paper are now taken and the last laid on its side upon them. The paper is cut round to the shape of the last, only about an inch larger than that required to fit the last. It is now serrated † or

* *Forme* is taken from the French, and corresponds to our "last." It is also called "last-shape."

† The serrations are likely to cause several errors, which if not corrected are calculated to cause trouble during lasting. Corrections may be made by totalling the amounts of openings when laid to the last.

notched, and one piece fastened—if a wood last, by means of a tack or drawing-pin, as shown in Fig. 103—to the last. The paper is bent to the last—care being taken that it is not pulled *up*, but *down*, imitating as far as convenient the direction of pulling followed by the laster—and where the strips cross the leaded straight line it is cut off, or folded to the line, and, after it has been removed from the last, cut on the board. This is followed all the way up the front and down the back of the last, and along the feather, turning or cutting it in the waist to the previously marked insole-shape. This completed, and removed from the last, the same process to be repeated for the other side. These are termed inside and outside formes respectively, as they are taken from the inner or outer sides of the last.

The formes require now to be *averaged*, so as to obtain a mean forme, that will enable both sides of the cover to be symmetrical, as is the trade custom. If the covers were produced from the two formes, they would be termed "rights and lefts." To average the formes, one of them is taken and laid upon a piece of paper and carefully marked round. The other forme is laid over this tracing, and also marked round. By splitting the distance between the curves in the several parts by a fresh line the *mean* forme is obtained.

This system of forme-making is recommended to obtain the knowledge of shape required in a flat pattern to fit the varying contour of the last. It is also suggested as a good plan to obtain the relative curves and relations of the leg and foot by using pieces of lining roughed to the shape of the leg and foot, and after serrating, pinning them together. Much information may thus be obtained. The same method may be used for an iron last, using copying lead pencil to mark the front and back sectional line, and cutting the rough shapes of paper from blotting-paper which, when damped and the last laid upon it, will leave a stain where it crosses the marked line. A little sealing-wax may also be used to fasten ordinary paper to the last. If due care has been taken to counteract the tendency of

the paper to curl up, or alter its *plane*, during bending to the last, by pulling it slightly in the direction of the laster's pulls, this method produces accurate results, and for a training method cannot be equalled.

The Marking or Measuring System requires the knowledge of the curves and proportions of the previous method's training, but is quicker and a practical workshop method. The principle of the system is that the points of measurement on the last and pattern are identical, and are all measured from a fixed point.* It enables a pattern to be produced that is calculated to lend itself to the usual method adopted in "lasting," and the differences that may be required in the fitting of an upper for various substances of materials can be made upon a uniform principle, and not simply by guesswork. The greater the number of points of measurement used, other things being equal, the better. For practical use, the following are recommended: length, toes, joints, and instep. To insure uniformity, the "table of distances from the toe," given in the last chapter, should be used for locating the "points" of measurement.

Description of the Method.—Take the last—by preference a left-foot one—and first mark on the front the

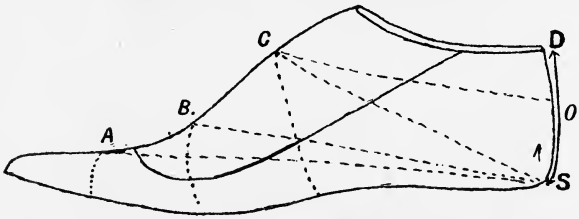

FIG. 104

position of measurement of toes, joint, and instep † (A, B, C, Fig. 104). Lay the last with the toe to the left hand upon a suitable piece of paper, and, bending the paper to the

* This system does not give the exaggerated shape that the Soule's system gives—if it be properly worked.

† If this were a ladies' 5's last it would be 1½ in. in 3 in. and 5 in. respectively taken from the top of the toe of the last in a straight line.

last, keeping a downward tendency towards the toe, mark upon the paper the positions of the toe, joint, and instep (A, B, C, Fig. 104). A line is drawn close to the top of the back of the last (D, Fig. 104) upon the paper, care being

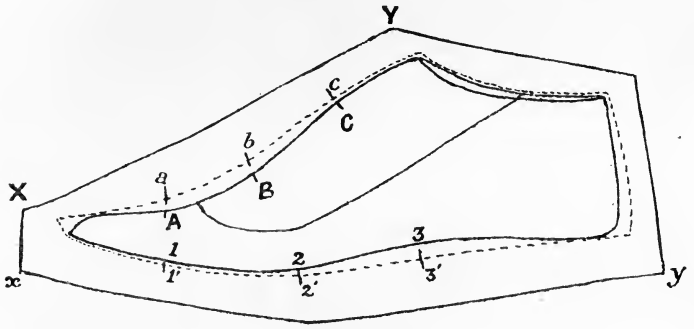

FIG. 105

taken not to move the last. The centre of the top of toe is now indicated upon the paper, and the bottom of the back of the last also marked. The training of Soule's system will enable a tracing to be made that will give an outline of the forme required. The dotted line in Fig. 105 will indicate this outline, where XY*xy* is the paper and A*a*, B*b*, C*c* the positions of the points of measurement. After this has been done — and it requires some little practice to do it properly—remove the last from the paper, and the forme will be as Fig. 106. It is now necessary to measure the last and pattern, and to make it correct. In principle a point of common measurement should be fixed. It is found most convenient to use the seat-point, and this is obtained thus: The instep point C, on the pattern and last, if carefully executed, coincides; also the top of the last, D, Fig. 104. These then enable us to establish the seat. The last is taken and measured from D to S (Fig. 104), and this measurement marked from *d* to *s* on Fig. 106, as shown. The last is also measured round from C to S (Fig. 104), and one-half of this taken, and from *c* (Fig. 106), marked towards the line made by measuring from *d* to *s*.

Where these intersect is the *seat*-point which is used as a starting-point for other measures. A point is sometimes taken at O * as a starting-place, instead of the seat, but the seat is recommended as most useful. A measurement from the seat round the last—keeping the tape or cord in as straight a line as possible on the last—passing through B, Fig. 104 (half of this is measured in Fig. 106 from the seat *s*), towards *b*, and where it intersects verifies the joint position. This is repeated for the toes *a*, and the positions 1, 2, and 3, Fig. 106.

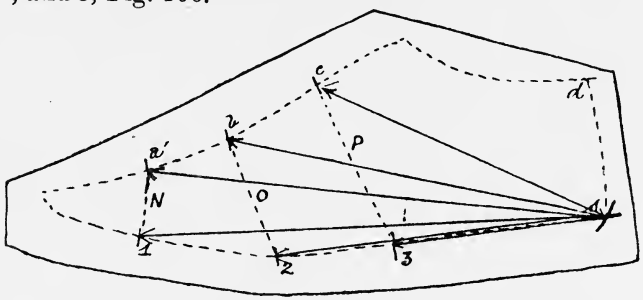

FIG. 106.

The girths are now taken, and if measured from "feather to feather," half of them applied to pattern as N, O, P, Fig. 106.

The length requires to be checked, which is done by using one edge of the tape or a piece of non-elastic cord, and, starting from the "feather" of the toe, proceeding up the toe to the top or puff, thence passing round the seat back again over the top of the puff, to the feather; half of this distance from the seat gives the length without lasting over allowances. In the hands of an experienced person, it is not absolutely necessary that the cutting of a *forme* be made a separate process, as it may be combined with the actual *standard*.

Lasting Over Allowances may be made by adding to the

* This point is located by a simple rule, viz. the height of stiffener; and is found by taking one quarter of the instep-girth from *feather* to *feather*; so that it varies according to the kind of foot or last, whether arched or flat.

nett forme an amount equal to the substance of the inner sole (if any), and the thickness of the upper. The amount will also vary as to the method of making, such as machine-sewn or hand-sewn. Sometimes these allowances are averaged in denominations of the inch, and at other times by allowing in length a certain fixed number of sizes over the length of the last, for the upper pattern. In the former way the table would be—

Hand-sewn ... ... $\frac{1}{4}$ in.
Machine-sewn, etc. ... ... $\frac{1}{2}$ „
„ „ stouter ... $\frac{5}{8}$ „
Welted ... ... $\frac{1}{4}$ „ forepart, $\frac{1}{2}$ in. in seat.

and the average on the latter plan would be—

MEDIUM SUBSTANCE.

	Fittings 1 and 2.	Fittings 3 and 4.	Fittings 5 and 6.
Men's.			
Machine-sewn	4 sizes.	4½ sizes.	5 sizes.
Hand-sewn	3½ „	4 „	4½ „
Women's.			
Machine-sewn	3½ „	4 „	4½ „
Hand-sewn	3 „	3½ „	4 „
Girls'.			
Machine-sewn	3 „	3½ „	4 „
Hand-sewn	2½ „	3 „	3½ „

The fitting of the last and its shape will cause these amounts to vary, as also will the stretchiness of the upper, and the mode of lasting.

Pitch is a term that is used in a variety of ways, to describe principles that are not identical. Sometimes it is used to signify the elevation of the seat portion of the pattern to accommodate the height of the heel, and when used thus it corresponds to the term as used by the last-maker. In this sense, a pattern may be said to be correctly or incorrectly pitched for a certain height of heel. The term is used also, and more usually, to describe the position or relation of the leg to the foot-covering portion of the

pattern. This is likewise called "leg position." The variations of pitch, in this sense, would be caused by (1) the formation or type of foot; (2) the upper would be pitched differently according to the substance of the material from which it is to be made, and (3) by the mode of lasting. In Fig. 107 a diagram of a flat and arched

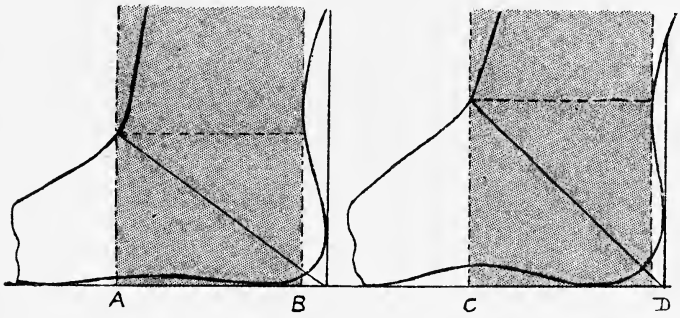

FIG. 107.

foot is given, showing the difference of pitch (used in meaning of "leg position") between them. The shaded portion AB shows the leg pitched forward, and, relatively, CD the leg pitched backwards. Assuming both of these kinds of feet had to be clothed with boots made from the same substance material, and lasted in identically the same way, then the patterns for them would be pitched differently. To make this fact the more evident, the illustrations Figs. 108 and 109 are given, the former showing a boot with a more backward pitch than the latter. It should be noted that if Fig. 108 were a correctly pitched boot for the kind of foot, then, if the boot shown in Fig. 109 were made for it, the one that was pitched too forward would cause a loose heel and wrinkles across the quarter, besides allowing the foot to go forward in the boot too much, needing a fuller jointed last and more length room. Fig. 109 is the style often made in the wholesale factories, because the excessive curve at the back and throat, when looked at in profile

in the boot, appears more stylish. The fact that, when the boot is put on, the two points mentioned become more

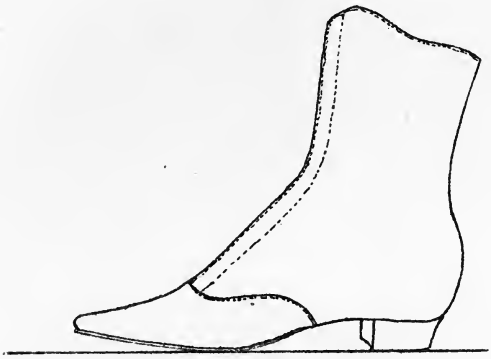

FIG. 108.

acute and relatively more forward is not usually taken into consideration.

The pattern would be pitched differently according to the substance of the upper. Assume that a light ooze calf and a leather-lined satin upper are cut respectively to the pattern that Fig. 108 was produced from, and, for sake

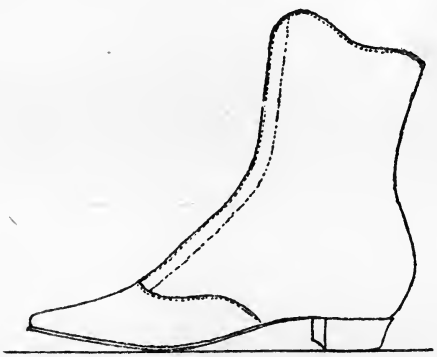

FIG. 109.

of describing the principle, assume they are identically lasted, then the lighter stretchy upper (ooze calf) would

assume the shape of Fig. 109, and the stouter (satin) would appear as Fig. 108; so that uppers of very light texture or of a stretchy nature require to be pitched more backward than those of a stouter or less stretchy material. The reason of this may be seen from the description of the "principles of lasting."

The mode of lasting will determine the pitch of the made up boot, and consequently it is often necessary to make provision for this in producing the *standard* pattern. Again, assume two uppers cut from the same material and by patterns which, when lasted the same way, would produce a boot as Fig. 108. Take one of these, and preparing the stuff and inserting stiffeners, etc., drop the upper at seat, say ½ in., and pull over at toe and last the upper. Next use the fellow upper, and drop it at the seat, say, 1½ in., and pull over the toe. The first upper lasted will appear like Fig. 108, while the second would look more like Fig. 109. These facts are not well appreciated or known by pattern cutters, and if comprehended would enable many difficulties that occur to be readily remedied.

Inclination is the term used to express the relation of the front line of the leg of the boot to the ground-line or flat surface upon which the boot stands. The correct inclination of a boot depends upon its kind, purpose, and heel. In speaking of the front line of the leg it is intended to be the profile line as seen above the throat starting from the ankle bone. During walking, this front line alters its relative position to the ground, while the foot is on tip-toe it is relatively forward. When the step has been taken, and the heel is brought to the ground again, it is relatively to the ground backward. Which, then, is the correct position to make the boot? The mean position between the extremes is the ideal. A boot constructed to carry a very high heel would require a different inclination to one made for a lower heel. It is customary to consider that the front of a boot should be at right angles to the ground, or flat surface upon which it stands, and

variations made for the kind of boot—such as colliers', side-spring, etc.—are made from this position.

Forme and Profile.—Before examining some of the methods used for producing a *standard,* or primary pattern, the difference between the covering of a last, or *surface-area,* and a profile, or section, should be understood. To do this, make a *forme* on Soule's system, but before removing the paper from the last, flatten it out and mark thereon the *profile.* This is done by keeping a lead pencil upright—the last lying on its side, above the paper—and tracing the outline of the last. It would be better, however, to make a *mean* forme, and also a sectional outline of the same last. Make a couple of lines upon a sheet of paper at right angles to each other, and lay the mean forme upon it, so that the horizontal line just touches the ball and seat, and the vertical line the back of the forme. Trace the outline, and repeat the operation with the section. The relative difference between them will be seen, and should be noted.

The last should now be fitted up, say on the joints, making it a full quarter of an inch greater in girth. A *mean* forme and *section* will be made from the "fitted-up" last.

Laying the last upon a flat surface, the distance of the top of the toe from the level surface will measure the same in the *bare* last and in the joint-fitted instance; yet when the two formes are placed upon lines that are right-angled to each other, the height of the toe, measured from the base-line, is not the same. The forme taken from the last that has been fitted, is found to have the toe at a greater distance from the base than the one taken from the net last. Repeat this with the two sections, and the toe is equally distant. The greater the joint-girth the more the difference between the section and forme at the toe. This is an important principle, and will influence the determination of the most correct of the methods for the construction of a *standard.*

The Standard Pattern is the initial one produced from

which the various parts are cut, such as vamps, quarters, linings, etc., and in a set of patterns is the one used to grade or scale the series from. It should be the finished shape with lasting-over allowances and draft made, and should have marked thereon the outlines of the vamps, etc. From the *standard* pattern, in this sense, is cut the lining pattern, quarters, and vamps, so that they may fit each other in proper relation. The standard may be completed from a previously constructed *forme*, or may be taken direct from the last, according to the system adopted and the experience of the cutter.

Constructing a Standard from a Forme.—This may be done by means of several systems. Some of these are based upon average relations without giving directly the variations needed for the kind of pattern best adapted to the particular type of last. Others have some relation to certain data gathered from the foot's proportion.

System No. 1.

> Based upon the observations that when the foot is raised at the heel, the curve at the back, above the heel, becomes more acute (when related to a stationary line), the higher the elevation the more pronounced the curve. The curve at the *throat* becomes straightened as the heel is raised.

First, obtain a surface-area covering for the last for which the pattern is intended. Draw a horizontal line, AB (Fig. 110), and at the right-hand end, B, erect a perpendicular, BC. From B, in the direction of C, mark D, which is the height of the heel desired, or that for which the last is built, less the substance of the forepart of the former. The *counter-height* * will be measured from D to point E. Also from D is measured the *ankle-height* † F. Find the centre between the *counter* point E and the ankle F, and name this G. Divide the distance between D and B into four equal parts, and from G, *towards*

* This may be obtained by taking one-quarter of the instep-girth of the last.

† This is taken as one-half of the foot's length, and for a size 4's (say) would be 4½ in.

the toe portion of the pattern, measure off one-fourth of DB, and name this H. Above F mark K, which is also equal to one-fourth of DB. From F make a line parallel to AB and equal in length to one-half of the ankle-measure (FM, Fig. 110). Through M draw a line parallel to CB and at right angles to AB. This line will indicate the front of the standard. The

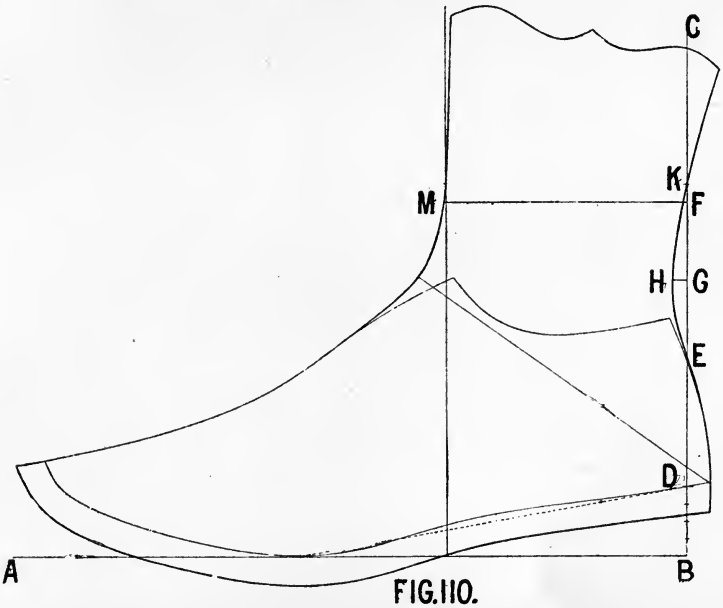

FIG. 110.

forme is taken and put level with the base-line, and at the same time touching point D and the counter-height E. Trace the *forme*, add lasting-over allowance, and measure the height of top of leg of pattern required. The heel-measure line may be drawn, and the *average* will be at 42° with the dotted line shown in the illustration. Complete the tracing, making suitable curves, and the standard will be ready for cutting out and will resemble Fig. 110.

The same method is adopted for constructing a men's standard, and is illustrated in Fig. 111, the counter-height E and ankle F being proportional to the size selected, and following the rule given for the ladies'. The marking of a golosh " to lock " is also exhibited on this diagram, the height of golosh being indicated at N. A straight line is drawn from

N towards T, which represents the "crease"-line of the golosh or vamp. At right angles to the crease-line draw the dotted

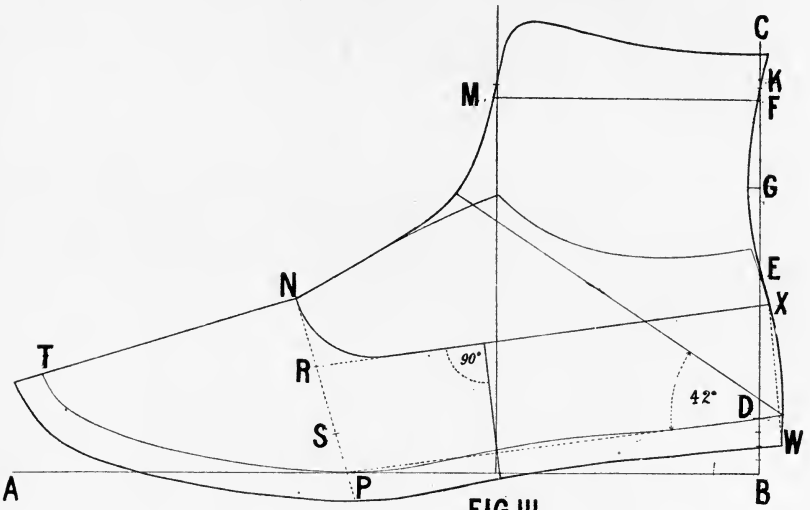

FIG. III.

line NP, and divide into three equal parts RS. From W measure the distance PR towards X. Join XR and obtain range of golosh. The front curve may be made according to the style of toe of the last. A pieced-golosh may be made by drawing a line from the edges of *forme*, where the front line passes, so that it makes an angle of 90° with the range-line (Fig. 111).

System No. 2.

This is the same in construction as the preceding, only instead of using a *forme*, the last is directly applied. Before the last is used it is well to mark thereon the positions for taking the various girth-measurements, and to do this the following will be useful.

Take a piece of manilla paper of convenient size, and mark lines at right angles to each other, as *a*, *b*, *c*, Fig. 112. Parallel to these make others at a distance of $\frac{3}{4}$ in. From *b* mark *b*4, equal to a size 4's joint-distance * from toe end, and at $\frac{1}{9}$ in.

* This is usually 3 in.

from this 4, above and below, mark other sizes. The instep-positions * are marked from *b* to 4′ on the inner side of slip.

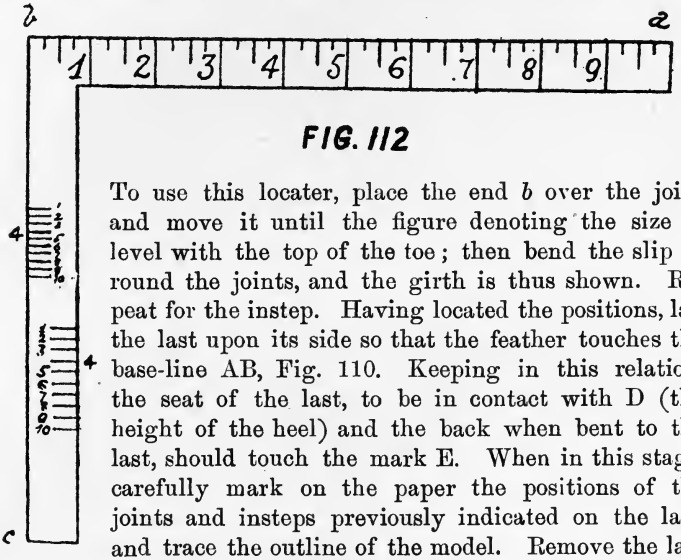

FIG. 112

To use this locater, place the end *b* over the joint and move it until the figure denoting the size is level with the top of the toe; then bend the slip *ba* round the joints, and the girth is thus shown. Repeat for the instep. Having located the positions, lay the last upon its side so that the feather touches the base-line AB, Fig. 110. Keeping in this relation, the seat of the last, to be in contact with D (the height of the heel) and the back when bent to the last, should touch the mark E. When in this stage, carefully mark on the paper the positions of the joints and insteps previously indicated on the last, and trace the outline of the model. Remove the last and measure the distances, and complete as Fig. 110 or Fig. 111. See also Fig. 105.

System No. 3.

This method is based upon the longitudinal location of the "ankle" in relation to the foot's length, and this proportion also gives the "ankle bone" height from the margin of the foot. In construction it is usual to assume the last as representing the foot, and to neglect the additional allowance of length of the last.

First obtain a *forme*, or surface-area of the last. Place the forme upon the piece of paper to be used for the standard construction, and trace its outline (Fig. 113). From C measure, in a downward direction, the height of heel the last will carry, or the height desired less forepart substance. Connect this point, B, with the swell of the joint, and construct the base-line. At A and B erect perpendiculars of suitable length, so that

* Size 4 may be taken at 5 in.

they pass the toe end, and the extreme back of the forme respectively. The base-line AB is divided into four equal

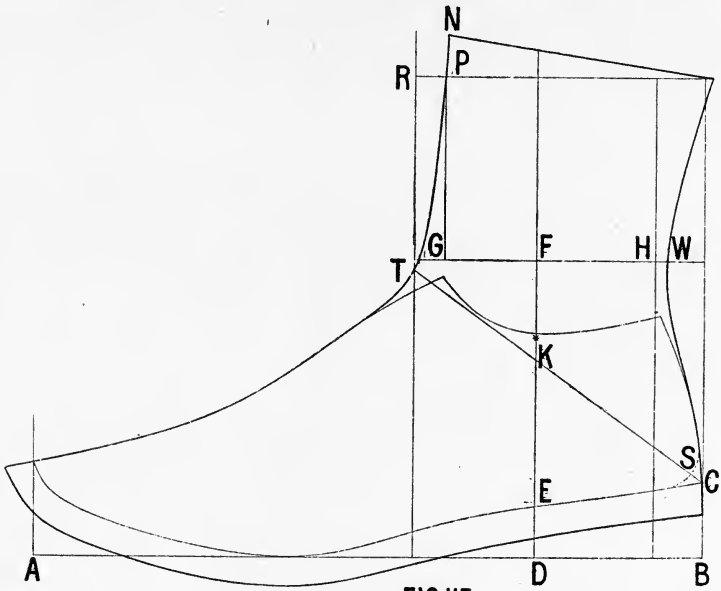

FIG. 113.

parts, and one of the sub-divisions, measured from B, is marked D. Through this point erect a perpendicular. From E, up the perpendicular line, mark the distance BD, and thus obtain ✳. Measure from ✳ $1\frac{2}{9}$ in. and indicate F. Through F make a line parallel to AB, and on either side of F make one-quarter of the ankle-measure, G and H. Through G and H draw line perpendicular to AB. Decide the height of pattern and mark.

Below ✳ make K, at a distance of one size, *i.e.* $\frac{3}{9}$ in. Passing K, draw the heel-line from C towards the "throat." If working from a heel-measure, taken direct from the foot, which is round, allow for the squareness of the last by measuring from C $\frac{2}{9}$ in. and fix S. From S the half-heel measure is to be placed towards T. From R mark P at a distance of $\frac{4}{9}$ in. Above P locate N $\frac{1}{2}$ in. away. The leg-measure is to be taken backwards from N. Complete the pattern as illustrated in Fig. 113, noting, when passing H, that W is some $\frac{2}{9}$ in. away. This is necessary, because the *last* length was used instead of the *foot*, and patterns must not be scooped out here.

System No. 4.

This method is the outcome of the fact that, when the heel is raised the curve at the back crosses a fixed upright line at a lower distance from the bottom than when not raised. This rule, that the lower the heel of the boot the higher up the curve crosses the perpendicular line, and the higher the heel the lower the point of contact, enables guide lines and positions to be fixed that will assist in the formation of the standard.

Fig. 114 is a diagram illustrating the application of this rule. A forme is made from the last to be used, and laid upon the sheet of paper from which the standard is to be cut. It is traced out, keeping the seat portion somewhat elevated to accommodate the height of the heel. After pencilling its shape, the substance of the forepart of the proposed boot is decided and this deducted from the probable height of heel

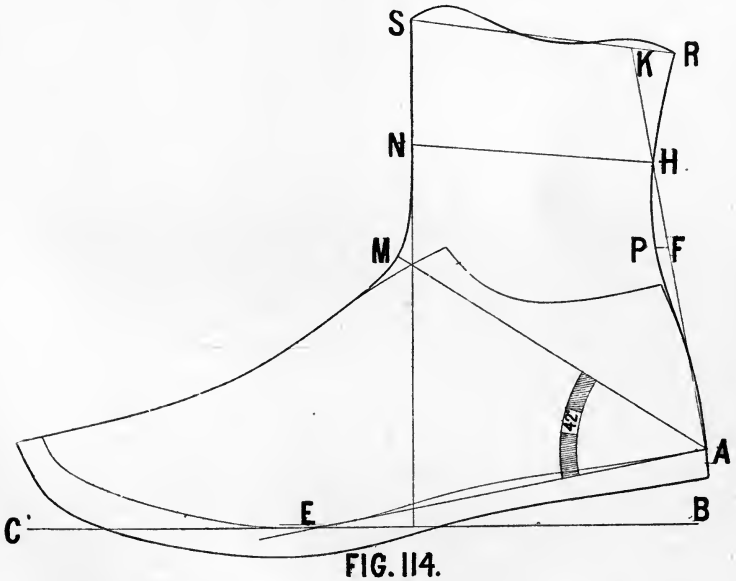

FIG. 114.

the boot will carry when made. The remnant will be marked below the seat of the traced-out forme in a position similar to

the direction in which the height of heel is to be measured. Through this point, B (Fig. 114), draw a straight line, BEC, touching the curve at the joint. Another line is made to pass from A to E, and perpendicularly to this line (AE), just touching the back of the forme, the line AFHK is drawn. This latter line is used to determine the points through which the back curve shall pass. To obtain these points, F and H are measured from A at distances varying according to the size of standard and the height of heel.

TABLE FOR ASCERTAINING THE HEIGHT OF F AND H.

Size adult.	F	H			
		1 in. heel.	1¼ in. heel.	1½ in. heel.	1¾ in. heel.
1	2 13/16	4 13/16	4 9/16	4 5/16	4 1/16
2	2 7/8	4 7/8	4 5/8	4 3/8	4 1/8
3	2 15/16	4 15/16	4 11/16	4 7/16	4 3/16
4	3	5	4 3/4	4 1/2	4 1/4
5	3 1/16	5 1/16	4 13/16	4 9/16	4 5/16
6	3 1/8	5 1/8	4 7/8	4 5/8	4 3/8
7	3 3/16	5 3/16	4 15/16	4 11/16	4 7/16
8	3 1/4	5 1/4	5	4 3/4	4 1/2
9	3 5/16	5 5/16	5 1/16	4 13/16	4 9/16
10	3 3/8	5 3/8	5 1/8	4 7/8	4 5/8

The ankle-line is drawn through H and made to equal one-half the ankle-measure. Through N a line is drawn perpendicular to the line CEB. The heel-line is drawn, which on the *average* would be at an angle of 42°, and on this line one-half the heel-measure marked AM, making such allowance as is needed according to the seat of last. The height of the pattern is now marked off, and the width of the leg measured back from S to R. From F mark P, the amount of which would vary according to the substance of the material to be used to make the upper, the "give" or stretchiness, and the mode of lasting. It is averaged at ¼ in. The pattern may be completed as illustrated by Fig. 114. The application to men's work is shown in Fig. 115.

The excessive curve produced at the back of this pattern, together with the "forward" pitch, may be remedied by substituting for the 4's pattern the measurements of 3¼, and 4⅝ in. for F and H, and increasing or decreasing from this data.

System No. 5.

This is a quick, and in the hands of an experienced person, a reliable method of producing

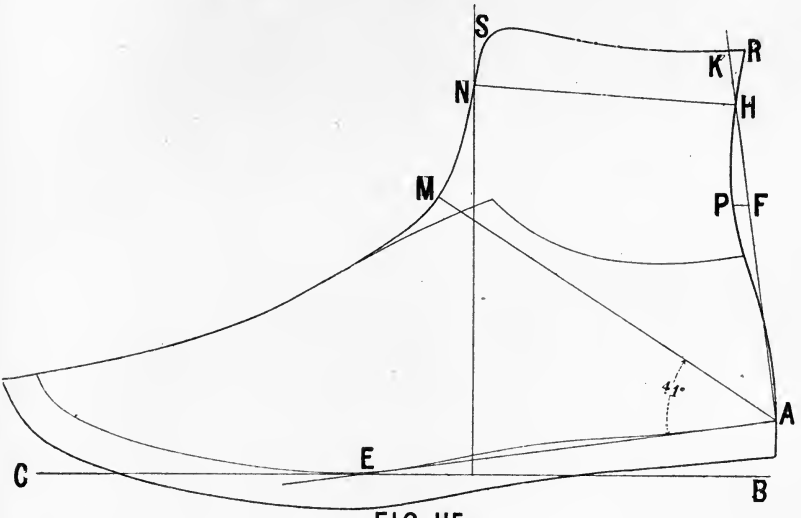

FIG. 115.

a standard direct from the last without having to previously make a forme. It is to be especially recommended for bespoke and handsewn work.

The last is taken and marked for position of joint, instep, etc., and the length and girths measured. To ascertain the

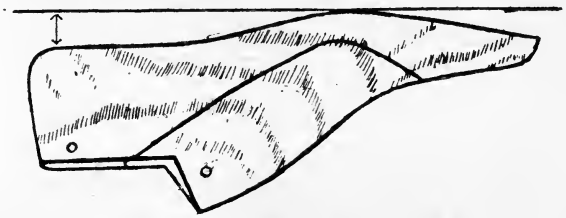

FIG. 116

height of heel the last will carry, take the last and lay the joint—or line of contact—on a flat surface, and raise the heel

until the seat is parallel to the surface, and if the spring of the toe be correct, measure at the back the height of heel, and transfer this direct to the pattern to be constructed (Fig. 116). If working to a given height of heel, the substance of the forepart should be deducted and the remainder used for constructing the pattern.

TABLE USED FOR FIXING "COUNTER" AND "ANKLE."

Size.	Counter (one-fifth last length).	Ankle (one-half last length).
	Inches.	Inches.
6	$1\frac{1}{3}$	3
7	$1\frac{4}{15}$	$3\frac{1}{6}$
8	$1\frac{1}{3}$	$3\frac{1}{3}$
9	$1\frac{2}{3}$	$3\frac{1}{2}$
10	$1\frac{7}{15}$	$3\frac{2}{3}$
11	$1\frac{8}{15}$	$3\frac{5}{6}$
12	$1\frac{3}{3}$	4
13	$1\frac{2}{3}$	$4\frac{1}{6}$
Adult.		
1	$1\frac{11}{15}$	$4\frac{1}{3}$
2	$1\frac{4}{5}$	$4\frac{1}{2}$
3	$1\frac{13}{16}$	$4\frac{2}{3}$
4	$1\frac{14}{15}$	$4\frac{5}{6}$
5	2	5
6	$2\frac{1}{15}$	$5\frac{1}{6}$
7	$2\frac{2}{15}$	$5\frac{1}{3}$
8	$2\frac{1}{5}$	$5\frac{1}{2}$
9	$2\frac{4}{15}$	$5\frac{2}{3}$
10	$2\frac{1}{3}$	$5\frac{5}{6}$

Take the sheet of paper to be used to construct the standard and make two lines, AB, BC (Fig. 117), at right angles to each other. From B, in the direction of C, mark D, the height of heel suitable for the pattern to be made. The *counter-height*, taken from the table according to the size selected for the standard, will be marked from D, giving point E (Fig. 117). F is obtained in the same way by using the *ankle-height* from the table. The length of the pattern, taken from the scale on p. 125, is measured from E towards H. From F the half-ankle measurement is placed to K. The last is taken and laid on the paper so that the seat and back coincide respectively with D and E, at the same time touching the line AB at the swell of the joint of the last. The last is traced and the *positions* of taking the necessary girths located in the same direction on the paper. The correct spring of the toe should also be registered.

The last removed, apply the measures to the pattern, following the principle of measuring all points from some other point or points. Care should be taken not to have the pattern "lark-heeled" at the back. The lighter and more stretchy the material, coupled with the presence or absence of a leather lining, so will this shape be influenced. The point N will show the usual shaping, while P would suit a non-giving upper material that is designed for a leather lining and suitable stiffening. The remaining stages of the completion may be easily understood by the inspection of Fig. 117.

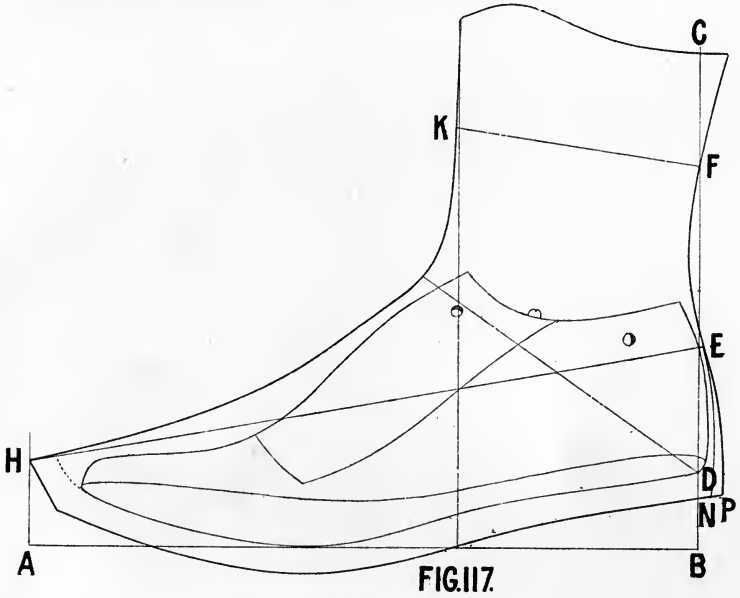

FIG.117.

Observations on Standard Cutting.—Care should be taken in producing a standard not to raise the toe of the pattern above the "spring" of the last, else when work, such as calf-patent, be made therefrom it will be difficult, if not impossible, to get the upper clearly lasted at the feather. If the standard be true, any allowances for spring, etc., for economical or drafting purposes, may be made upon a proper basis, enabling uniform results to be obtained under similar circumstances. Uppers that are "too dead" in the

toe are difficult to last in the waist, being tight and required to be "nicked," while those "too springy" have the forepart too full with a redundance of "pleats" and "wrinkles." The standard should be of correct length, and as perfect in its fitting properties as possible, because the whole set of patterns will depend upon the primary standard having its correct relations. Differences in length and lasting-over allowances must be made for different classes of manufacture. The allowances for turn-shoe work are the least, and hand-sewn, machine-welted, machine-sewn, riveted, etc., require various amounts suitable to the demands in making. A standard cut for a last to be "fitted up" requires, not only width-increases, but also additional length to allow for the extra fitting.

The curves of the made-up or completed boot must not be imitated in the pattern. Curves on a flat surface look different when bent to the last or foot. Sharp curves become sharper, the throat and back requiring special care. The flattest, plainest-looking standards will often produce the smartest-looking and best-fitting boot. The waist of the pattern should not be scooped or hollowed out too much, as the upper should not be pulled transversely across the instep to such an extent as to spoil the draft put in the boot by hoisting and well-considered pulls of the previous stages. Separate patterns and sets should be used for heavy and light work, both because of the additional lasting-over allowances, and for the differences in the substances and "give" of the upper material. The toe of standards for fabrics should not be "sprung" as much as for leather, but should fit the last exactly.

Shoe Standards require several principles (not so vital in the construction of a boot standard) being observed. The quarters of a shoe have to be arranged so that when on the foot they will grip well at the sides under the ankle, and also fit the heel snugly, to prevent the "up and down" motion often experienced with badly designed shoes. The first important feature, to ensure a correct fit, after the

selecting of a properly constructed *shoe* last, is that the shape of the back shall correspond to that of the foot. It must not be hooked, as shown in Fig. 118, C, else it would cut the foot when worn; or more likely the seam

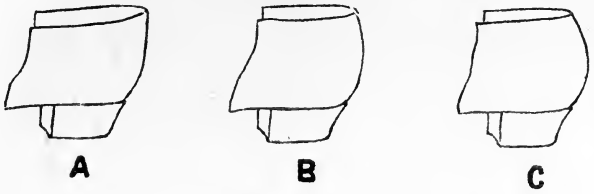

FIG. 118

would give way during the process of making. The correct shape of the back of the shoe is shown by B, in the same illustration, while A shows the reverse of C, it being the usual kind of shoe produced by cutting down a boot standard, or by making upon a boot last.

The correct shoe should have a tendency for the quarters * to come together when made, and should have the appearance of Fig. 119. The waist of a shoe pattern should not be hollowed or scooped out, as any strain

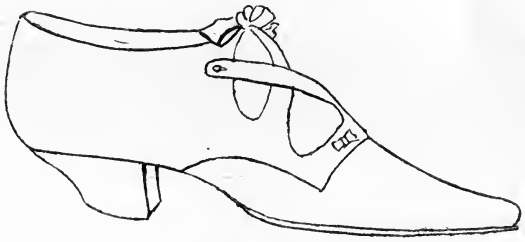

FIG. 119

caused transversely at this point in lasting would tend to make the quarters gape, and would defeat the primary point to be observed in cutting a shoe pattern.

* The *edge* of the quarter must not be confounded with the *quarter*.

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System No. 1.

Take a *forme* or surface-area pattern of the shoe last it is desired to make a standard for, and lay it on a sheet of suitable paper above a horizontal line, AB, Fig. 120,—the seat of the forme being distanced from the line AB equal to the height of heel the last will carry (refer Fig. 116). Trace the outline of the forme. To fix the height of the back of the shoe will be the next step. There are several rules for determining this amount. A good rule is first to fix the stiffening, or counter height, which may be done either by taking a proportion of the length of the last,* or by using a ratio to the instep-girth. The latter rule has advantages to

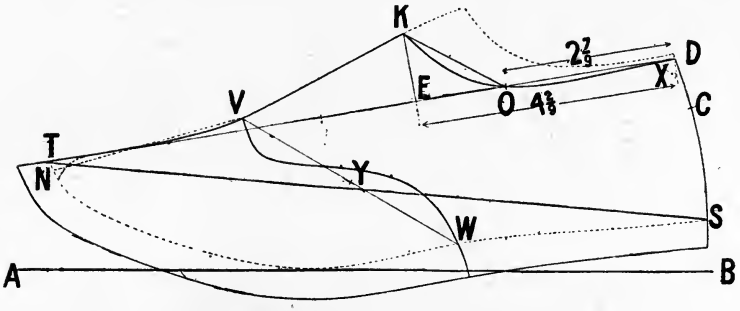

FIG. 120.

recommend it. One-fifth of the entire instep-measurement may be used and located from the corner of the forme, as C, Fig. 120. The height of the back above C for this ratio will be $\frac{7}{9}$ in. This will give D. Join DT. From T measure a distance along TD, $\frac{1}{3}$ in. *less* than TS, so as to ensure the "draft" or tension at the top of the shoe in its relation to the bottom edge (see X, Fig. 120). From X, along the line DT, mark, for size 4 adult, $4\frac{2}{9}$ in.† and obtain E. Through E, at right angles to DT, draw EK. From K to O make a suitable curve, and from O to X another curve, keeping it as straight as possible consistent with the style required. The line of the front of the shoe that passes from K to V should be

* One-fifth of the last length is the basis of this rule.

† If a lower shoe is desired, use $4\frac{1}{2}$ in.

nearly straight, as shown in Fig. 120. To complete, add lasting-over allowance, and cut out.

System No. 2.

A *forme* may be used for this method, or the measurements taken direct from the last. Fig. 121 is an illustration of a man's shoe. Draw a base-line, and provide for the height of the heel in the usual manner. If a forme be used, trace its outline, ABCD. From A measure the height of the shoe required at the back. This may be taken from the rules mentioned in "System 1," or the rule of making the height of the back equal to the joint-measure of the pattern, *i.e.* AB to equal VQ. One-quarter of the last-length is sometimes used to regulate the height

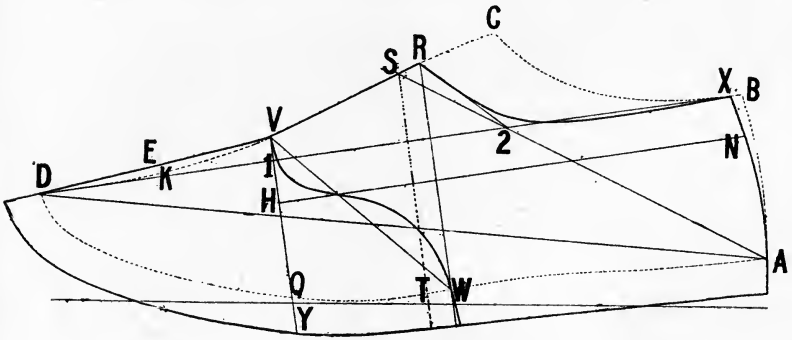

FIG.121

of back. Join BD and make DX equal to DA, less one shoe size ($\frac{1}{3}$ in.). Divide XD into three equal parts at 1 and 2. Through 1 make a line perpendicular to DX, as VQ. Where this transverse line cuts the front of the forme gives the vamp height, V. Through 2 make a line from A to S. Draw ST at right angles to XD, and, if a low shoe with short vamp is required, the front of shoe and end of wing of the vamp will be determined. In the illustration a shoe higher than this is shown, and from S to R, a distance of $\frac{3}{8}$ in. is made. Join R2. Add lasting-over allowance suitable. H is found by taking $\frac{1}{3}$ of VY. Draw HN parallel to DX, and where it crosses the line that passes from V to W will locate

where the curve of the vamp may pass. Complete the outline as Fig. 121.

Shoe standards should not be trimmed, for any reasons, at the top of the back of the quarter—sometimes done mistakenly for *draft*—as N, Fig. 122. Neither take off an amount such as R from the bottom, and leave on an equal amount, T, at the top (Fig. 122). In the former case the *edge* of the quarter only would have a binding tendency, and the shoe back is thereby rendered liable to injury in the withdrawal of last after the shoe is completed. The second case, of cutting off the bottom, would make the long-heel measure of the pattern smaller, and does not therefore add to the correct fitting properties of the shoe. A serious error, often committed with the idea of making

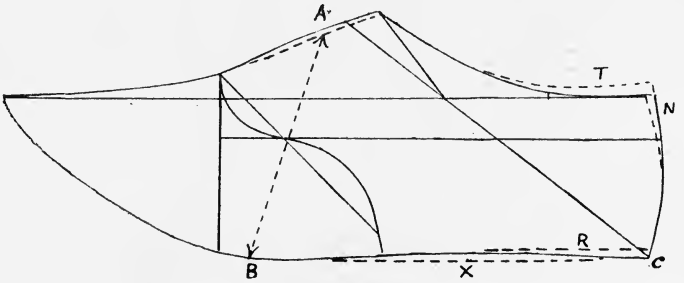

FIG. 122

the shoe grip well, is to cut off $\frac{1}{8}$ in. from the instep, A, Fig. 122, adding the same amount in the waist, X, so as to keep the instep measure of the pattern the same. This will shorten the long-heel measure, AC, and will also cause the shoe to be tight in lasting from A to B. If the desire be to "draft" the shoe standard, it should be drafted on the same principle shown for a boot standard, p. 158.

Vamps.—It is difficult to give any single rule of proportion fixing the height of a vamp, owing to the differences that have to be made between boots and shoes, high and low heeled work, and for accommodating the various sorts of toe-caps. It is usual to make vamps for shoes lower than

would be the case for boots, and high-heeled work requires shorter vamps than those used for low heels. A low vamp for low heels would be exceedingly uncomfortable. If vamps are made too low they give the appearance of wide joints, and cause more waste in cutting. If the vamp is to be capped it should be made higher than it would be without caps, the kind of cap—whether straight (Fig. 126),

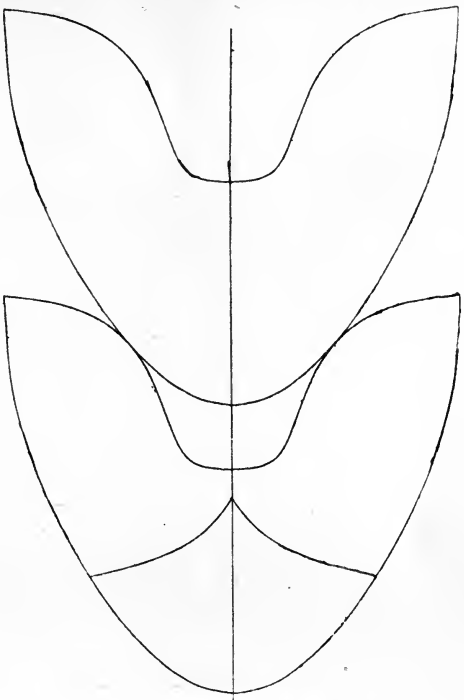

FIG 122A

pointed (Fig. 122A), or peaked (Fig. 126, B)—deciding the difference. It is recommended that as far as possible the heights of vamps be reduced to a proportion of the forme or last-length, or in relation to the position of the joint of the foot. Reducing it to a ratio of the last-length has advantages over the forme-length; the former being preferable, because the forme will vary in length with the

fitting of the last, whereas the length of last will be the same in the various fittings of the same size. As an instance, one-fourth for low and one-third for high vamps, for women's and children's work, and one-third for low and two-fifths for high, in men's and boy's work, would give a basis for regulating vamp-heights.*

The length of wing admits of more definite treatment by rule than vamp-heights, and should be decided upon by approximation to the instep-line of the pattern. A long-winged vamp is expensive to cut, and in the made-up goods prevents the easy entrance of the foot, besides causing much difficulty in paste-fitting and stitching. Vamps with short wings are cheaper to cut, especially if the material to be cut requires a system, as Fig. 122A.

The curve, throat, or cue of the vamp should be designed in harmony with the style of toe of the last; a narrow toe looking better with a smart, and a square toe with a squarer cut curve. The curve for a button-boot vamp should be designed easy, giving a little extra freedom to counteract the tension caused by the fastening of the button-piece. Lower vamps are used also for this reason, upon button or other work causing a tying tendency, to prevent abrasion on the foot. High vamps should not be used for lasts that fall away suddenly below the instep, but, if they are required, a "fitting" or "shover" should be used in making, and care taken not to spring the toe of the upper. Vamps for derbies and similar designs should not be high, unless proper provision is made in the last to prevent any cutting tendency of the edge upon the foot, and in the pattern to balance the effect of the curve on the standard below that of the *crease-line* of the vamp (compare E and K, Fig. 121). The vamp cut from a standard, as shown in Fig. 121, would be pulled in lasting from E to K, and the tension that would fall at V would cause that edge to bind when on the foot. It may be often remedied by "deadening" the toe when the shape of the

* Children's work should not be cut, as a rule, with very low vamps.

toe of the forme is as shown in Fig. 120, where the dotted line VN shows the *crease-line.* Care must, however, be

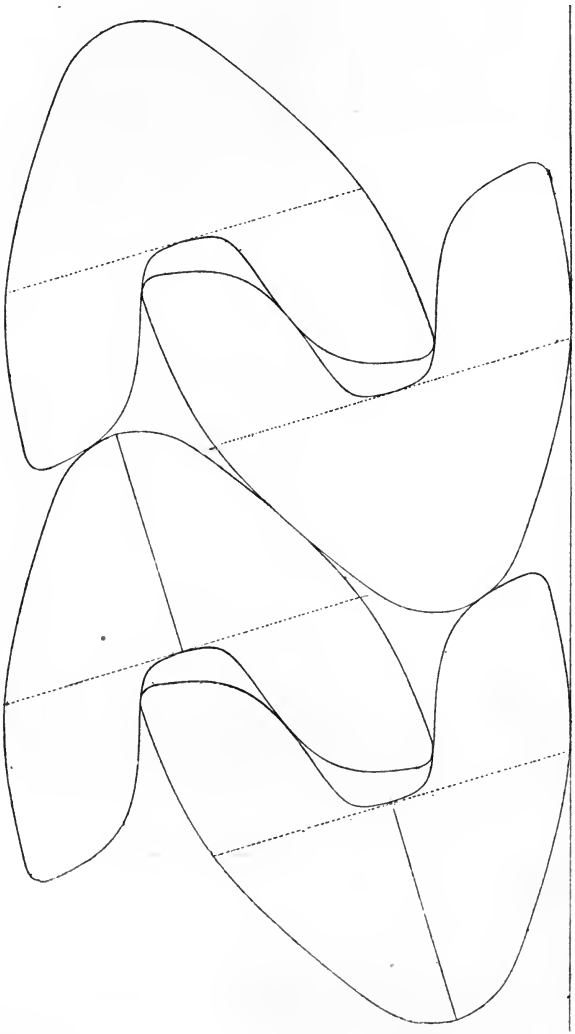

FIG. 123

taken not to put the crease-line below the end of the toe, or the upper will be too tight round the edge of the last and difficult to "last in" at the waist. Vamps may be cut to

interlock, and in cutting small areas this is of great advantage. The extreme corner of the wing may be

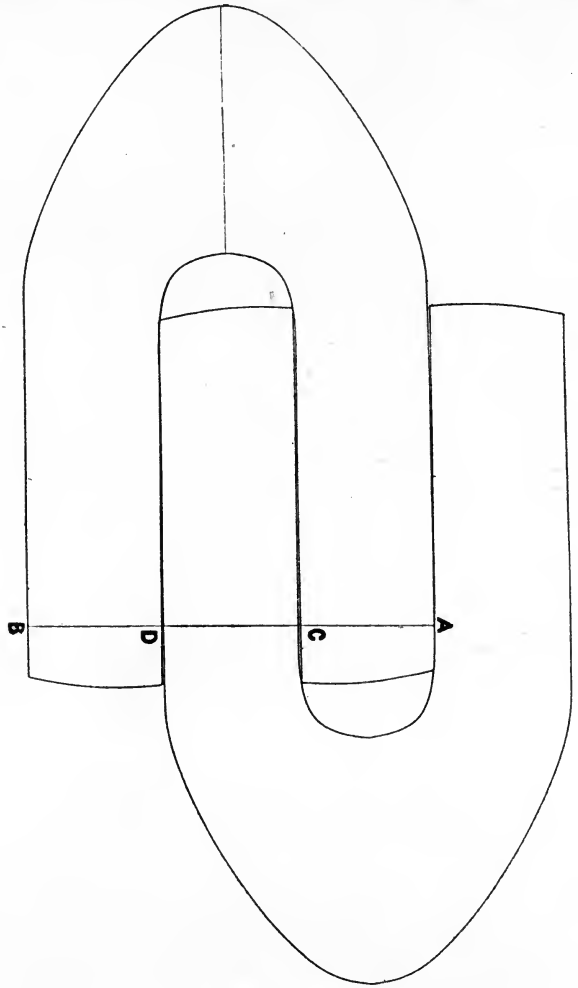

FIG. 124

removed, but must not be overdone. Fig. 123 will illustrate this principle, and it is specially adaptable to vamps with long wings, only it often requires some sacrifice in

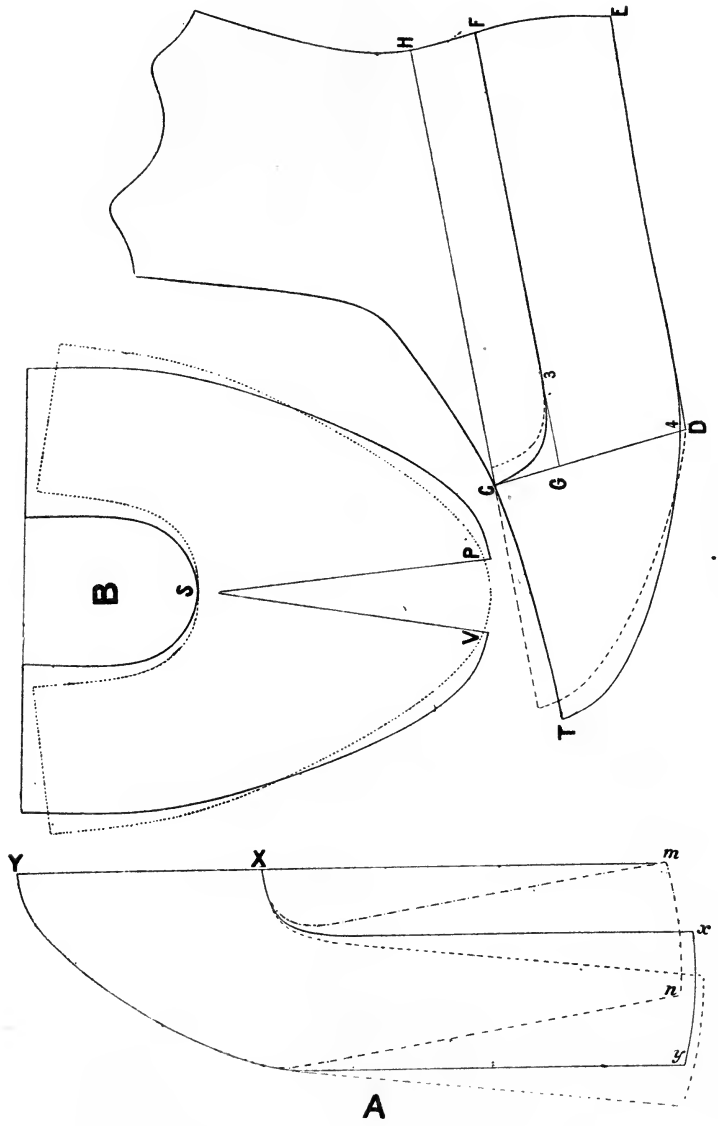

FIG. 125

the smartness of the shape to effect the full economy desired.

Method of Designing.

Fix the height of vamp V and length of wing W (Fig. 120). Join this with a line, and find centre Y. The curve of the vamp may be made to pass above Y, at a distance of one, two, or three-ninths of an inch, according to the style required.

Another Method.

This is illustrated by Fig. 121, and is described on p. 143. It is adaptable to designing circular or square vamps that have to be locked, and fitted on the flat system. To attain the latter, draw the crease-line VED (Fig. 121), and through H draw a line parallel to VD, and where this crosses the line that passes from R to W measure downwards the distance VH, and complete by sketching curve of vamp.

The Springing of Vamps is resorted to for several purposes. It is an old custom, owing its primary origin, no doubt, to the kind of pattern then in vogue, and used to give "draft," or *set,* to the vamp. It is used also for economical reasons, especially with patterns that are cut from lasts that have a small amount of spring, and are flat in the toe. In fabric-lined work, if the vamps are "sprung" it prevents the foulness of the lining when the boot is completed. Vamps that are cut from standards that are "dead," spread open, and are not so convenient to use in cutting leather to best advantage. Fig. 126 shows a vamp, ABC, cut as marked on the shoe-standard. The half DE shows the vamp with more spring, and it should be noted that the lasting edge is increased by twice the amount of EB at the toe. The dotted tracing shows the same vamp made more "dead," and in addition to the increase in the distance from the central line *xy,* before alluded to, the edge has decreased at the toe by the amount BH. By springing vamps greater economy is observed in cutting leather by interlocking, and the edge of the upper is increased in length of that over the standard, so that extra

material has to be lasted in. On the other hand, the opposite is the case with vamps that are too "dead." The nature of the leather must be taken into account when springing vamps. It will be seen from what has been said respecting the lengthening of the bottom edge of the upper, that to spring vamps for materials that are stubborn to last would make it difficult and impossible for the boot to be lasted without wrinkles.

The amount of spring to be used over that of the standard * is as follows:—

Patent leathers	none on any account.
Light wax calf, Russias, satins, and firm kid-calf	$\frac{1}{8}$ inch.
Soft English and German (soft) kid, glace, and *very* supple wax calf ...	$\frac{3}{16}$ "
Glove-kids	$\frac{1}{4}$ "

If the standard bears the relation to the forme as illustrated in Fig. 120, the above amounts should be modified.

If standards are drafted properly, the springing of vamps may be omitted with advantage in cheaper classes of work.

How to spring Vamps.—There are two methods of performing this—one being to elevate the toe of the vamp the required amount above the toe of the standard, and then complete the cutting in the usual way, shown in Fig. 126, from AB to FE; the other plan is to cut off from the bottom the desired amount, and to add it to the top of the wing of the vamp, which is illustrated by the principle shown for springing a whole golosh (Fig. 125, B).

Goloshes may be designed upon one of three principles: (*a*) cut dead to the standard without any spring; † (*b*) cut to interlock—one wing between the others; ‡ (*c*) with an excessive amount of spring.§ For certain leathers and

* It must be understood that the standard must not have been sprung consciously or unconsciously in constructing.

† Fig. 125 shows such a design; useful for such leathers as patent, or very deep goloshes.

‡ Fig. 125, A; XY*xy* shows an interlocked golosh.

§ Fig. 125, A; XY*mn* shows the outline of golosh on this principle—only to be used with very soft leathers.

classes of trade the interlocking golosh possesses economical

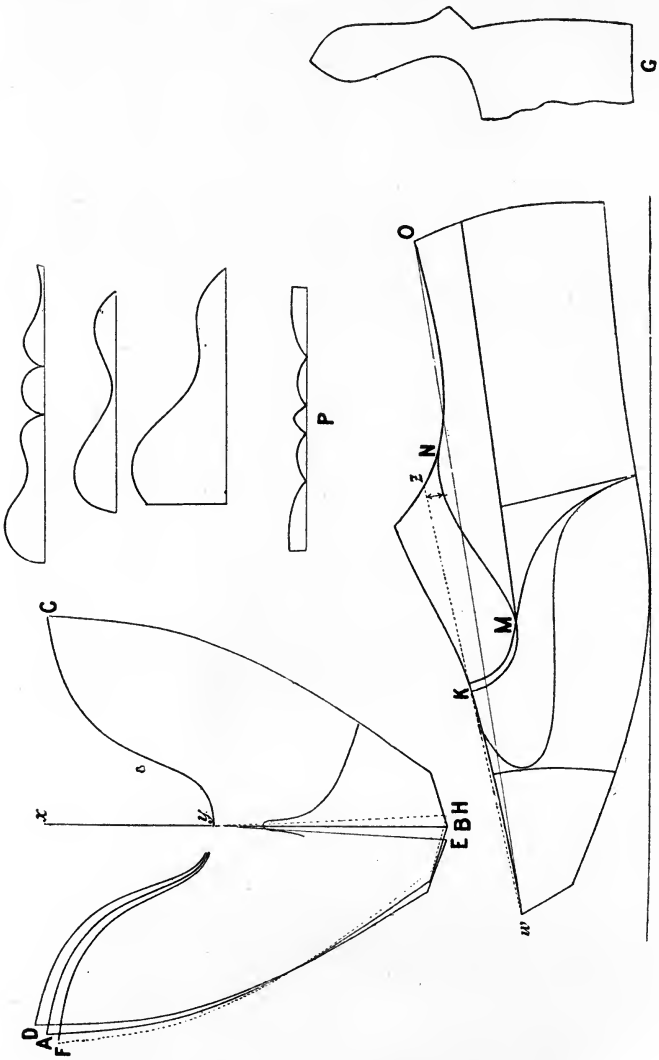

FIG 126

advantages, but it cannot be adopted for high goloshes, or where an unusual amount of lasting-over allowance is

made, and the average height of golosh is desired to be maintained. Whole or joined goloshes for patents should not be cut to interlock, owing to the trouble given in lasting, and the wrinkles or pleats that are to be found in the finished boot when so interlocked. For such work, cutting dead to the standard is recommended, the space between the wings being utilized for caps, etc. Goloshes are sometimes used, cut upon principle (*c*), but care should be taken that only such supple leathers as Bordeaux calf be used, and that after they are cut out, they are pulled to remove the excess of spring. Examine Fig. 125, A.

The height of a golosh vamp is greater than in a vamped boot, and a difference is also desired for stout work, while lighter work may be lower. About one-fourth of an inch in excess of the usual vamp heights is a good proportion, the same differences being made for "caps" as with vamped work.

Flat-toed, full-waisted lasts, with low insteps and heels, do not lend themselves to the interlocking arrangements. Also it is not possible to obtain with a very full-jointed last the same depth of wing that may be used for a narrow-jointed one. If the lasting-over allowance is large, as in the case of stout outsides, with stout lining, etc., locking goloshes can only be produced to a certain height, viz. one-third of the joint pattern width (see Fig. 124, where BD is one-third of AB). Some lasts require "right and left" goloshes cut to enable the upper to be properly lasted, and the finished article to present a square position.

Method 1.

Having determined the height of the vamp N (Fig. 111), draw NP at right angles to NT. Divide NP into three equal parts, by R, S. Through R draw the line RX parallel to a line passing from P to W. If a joined golosh is required, it may be taken from the whole golosh by making—from the point marked by the line that passes from M, Fig. 111—a line at 90° with the line RX. This would give an interlocking golosh.

Method 2.

Goloshes designed not to interlock should have the vamp-length marked. The height of the back of the golosh may be determined by the counter or stiffening depth, rules for which have been given. The line at right angles to the *crease*-line of the vamp should be drawn, and a midway distance * between the one-third and one-half of this line, *without* lasting-over allowance, fixes the other end of the golosh. Cut out to the dead standard. Suitable for patents, etc.

Method 3.

Fig. 125 show a women's pattern with an interlocking golosh marked thereon. It is designed by indicating C, the height required. Draw CD at right angles to crease-line CT. Join DE. G is one-third of CD. GF is parallel to DE. The dotted line CH shows the folded edge of the paper used for cutting the golosh. If the golosh were cut *strictly* to the markings given, no room would be allowed for the knife to pass between the wings of the pattern when cutting out. Further, the leather has substance, and when placed in position would not reach the desired point made on the paper, therefore arrange the folded edge of the paper to be used, at a suitable distance from CH, before cutting out the golosh pattern. This will give the requisite clearance, etc.

Method of cutting and springing.

Fig. 125, A, shows tracings of goloshes cut to 125, and there indicated by the chained-line outline. The fixing of a "pivot point" from which to spring the golosh, so as to retain its correct length and shape of curve, is the first step. This is often done by using C, Fig. 125, and by placing a needle-point through it, and the folded paper beneath it is thus made a point, by means of which the wings are elevated, so that the top edge or range of wings is parallel with the folded edge. This, however, is not a correct way, as it gives a golosh too long, and a curve in front which, when the golosh is fitted, does not represent the one originally designed. Then G is often selected as a pivot-point, and is certainly

* This would be correctly expressed by five-twelfths of the joint-line minus lasting-over allowance.

productive of a better-fitting golosh. The point 3,* Fig. 125, is also sometimes used. When this point is adopted, a deeper golosh wing may be produced, nearly one-ninth of an inch. The best process is to take the standard and lay it upon the folded edge of the paper to be used for cutting the golosh, putting C and T (Fig. 125) level with YX*m* (Fig. 125, A). Trace while in this position, from T to D, and C to 3 (Fig. 125). Place the needle point, or tip of the finger on G, and raise the wing until GF is parallel to CH, the folded edge. Mark from centre of front curve to 3, and thence to F. Return the standard to the first position and use 4 (Fig. 125) as a second pivot, raising the wing until F on the standard coincides with F on the golosh tracing. Trace bottom and back, and the golosh will be as YX*xy* (Fig. 125, A). Proceed for excessive spring in a similar manner, and a tracing as YX*mn* (Fig. 125, A) will be obtained. Seaming, stretching, etc., allowances will now be made, and the golosh cut out. See also Fig. 124.

A golosh vamp is illustrated in Fig. 125, B, the dotted one showing the vamp cut dead, the other marked vamp, cut with spring, using S as pivot. It should be noted that the length round edge has been increased by the amount from V to P, which will be "foul" in lasting.

The effect of springing the golosh is to tighten the top, and to lengthen the bottom edges. The seam at the back of a golosh may be obviated by cutting it as shown in Fig. 126, G.

Other Parts of Standards are shown in Fig. 126. The *wing, circular vamp, square vamp,* and *back golosh* need no further comment. The whole-cut shoe is a type of a principle that is applicable to several designs (such as canvas, athletic, insertion shoes, etc.), and is here given to represent, by KMNO, a turned-in front whole-cut shoe, fastened by a fancy-cut inserted strap. After the line *w*O has been drawn, the *crease*-line *w*K*z* should be made. From this line a distance equal to the amount required

* This point is found by taking from G the distance GC.

for turning-in is marked (indicated by arrow). The curve NMK is made, crossing the line from O*w* at a proportion of one-third from the top edge. If canvas, etc., requiring an instep-piece, the curve may touch the crease-line K*z*, the instep-piece or facing having a suitable overlay. Not much variety is usually made in the shape of the tops of standards, the *volute* (Figs. 117, 114) being the rule. Figs. 110, 125, 126 P, show a variety that may be adopted. The top one (Fig. 126, P) is of geometrical construction, and is given to illustrate what may be done in this respect.

Standard Drafting.—Drafting, or draughting, is rendered necessary in the making of boots and shoes, owing to the material employed in their construction, and the cut of the upper. Leather is a flat substance, possessing stretch in varying directions, and has to be "blocked" or "lasted" to the different curvatures of lasts, during the manufacture, thus removing—according to the efficiency with which it is done—the *superfluous* expanding properties that would during wear—if not removed—cause a constant change in shape and measurement, making the goods unsightly and uncomfortable. To counteract this "giving" property of leather, the upper is drafted during making, this operation imparting a *tension, strain,* or *draft* in the upper from counter to toe, that insures the tendency of the upper to close together when removed from the last. When the weight of the body is transferred to the foot, and thus the strain is thrown upon the upper, the *tension* or *draft* prevents its undue yielding and consequent loose fit. This tendency of the opposite sides of the upper to approach each other is usually tested by taking the well-made boot, say, in the left hand by the sole, and then with the right alternately, gently pulling and releasing the leg portion of the boot. The set or sit of the boot depends upon this draft or tension.

The operation of drafting by the maker may in some instances be assisted by making a modification in the pattern; but such alteration to be effective must be based

upon the same principles that are adopted by the laster. Much is done to a pattern with the idea of "drafting" that does not in the least assist in the process; so that it will be well at this stage to examine the fundamental principle. The longitudinal strain, produced by dropping the upper from the seat upon an inverted last, and by pulling it well over the toe by a series of correctly directed pulls, in fact, reduces the length of the bottom of the upper to that of a length from counter to toe. When the upper is pulled up at the back this shortened length has to be replenished by

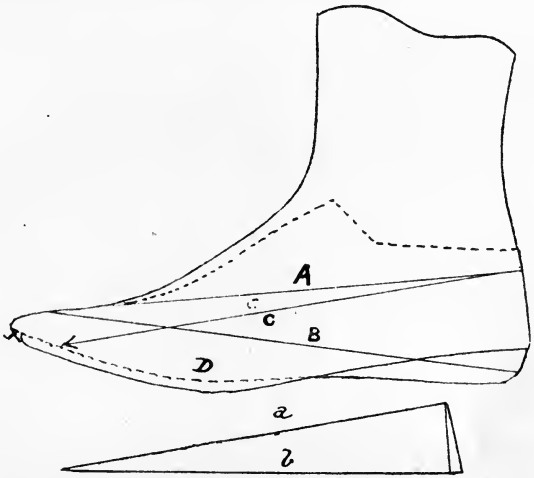

FIG. 127

taking extra stretch from the upper, and this extra strain gives the tension, or draft. The sketch (Fig. 127) will make this clear. When the upper is pulled up at the seat it ensures the tension or draft along the line A. This is assisted by C and other "lines of pull." If the upper is very "dead" it is very difficult, if not impossible, to obtain efficient draft, and it will also be very tight in the waist. An upper with a springy toe will draft well, and the waist will be easy to last, but there will be surplus or "foul stuff" to dispose of somewhere in the fore part.

It is not necessary to draft a well-designed pattern, and to do so for some work would be a serious detriment to its manufacture. Drafting, when adopted, must not be done by taking an amount off the seat of the pattern, gradually diminishing to nothing at the waist, because this would only have the effect of making the heel-measure too small, causing an undue strain from instep to seat. Even when removed from the *forme,* before constructing the pattern, it is erroneous; by its lessening the measure from instep to

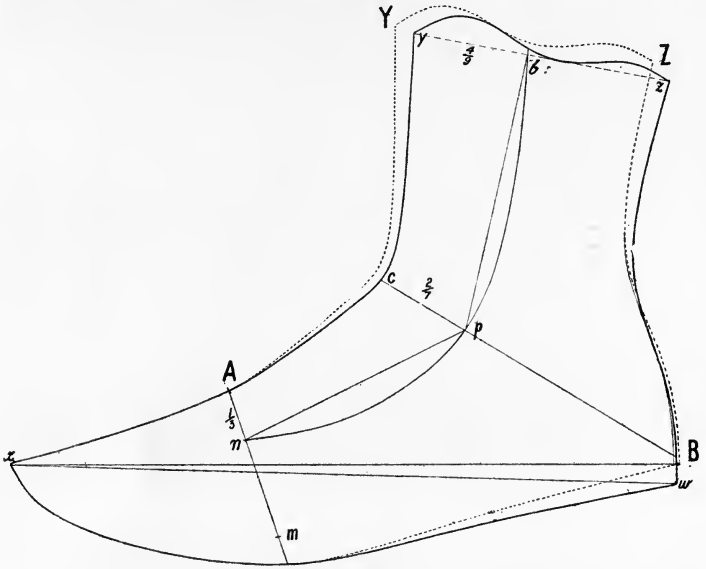

FIG. 128.

corner of the heel, thus causing the instep of the upper to fit the last "too soon," the inclination thereby being affected. In a shoe, an amount must not be taken from the instep and left on at the waist with an idea of "draft," because this will reduce the long-heel measure, and the measurement from instep to joint making the upper difficult to last properly. Sometimes an amount is removed from the bottom of the pattern of a shoe and placed to the credit of the top of the back—keeping the transverse

measure the same, it is true—but when the upper cut from this pattern is made, it will be too full in the waist, and the heel-measure will be too small.

The correct method of drafting a pattern, assuming that drafting is necessary, either boot or shoe, is shown in Fig. 128, where *wxyz* is the standard to be drafted. For light uppers the amount B is not to exceed $\frac{3}{9}$ in., while for stouter work $\frac{2}{9}$ in. would be sufficient. Shoes may have a little more, say $\frac{1}{9}$ in., than boots. Having traced the outline of standard and decided B, place a finger on A and raise the pattern so that *w* coincides with B. Trace dotted outline YZ. Correct the length by making *x*B equal to *xw*. A pattern cut to fit the last properly, and curved as Fig. 114, with the correct *leg position* would not need to be "drafted;" while a pattern like Fig. 129 would be easier to last if drafted. When making the latter kind of upper, it should be pulled at D (Fig. 127) before raising the seat of the upper, so that the correct inclination may be obtained. Before deciding to draft a pattern it should be ascertained if it correctly fits the last. If it be found to be "springy" at the toe it will not require so much draft, *i.e.* elevation from *w* to B (Fig. 128), as a closely fitting toe. The *forme* in Fig. 120 has the toe cut strictly to the last, and to obviate any spring the vamp-crease TV should be carried from V to the corner of the toe, or at least to N.

Button Boots.—The standards for this shape of boot should be fuller in measurement at the instep, heel, ankle, and leg, than those cut for lace or elastic-side work. For stout material this allowance must be greater than for lighter leathers. The average amount over the lace pattern may be taken as $\frac{2}{9}$ in. and $\frac{1}{9}$ in. respectively. The width of the button-*fly*, *piece*, or *bit*, should not *exceed* one-half of the leg-measurement of the pattern. It is said it should not be *less* than one-third. A good proportion of button-piece is to take four-ninths of the leg-measurement. This is shown in Figs. 128, 129. The shape of a button-bit edge may vary a good deal, according to the taste of the designer

and to the class of trade catered for. If the fly is to be scolloped they should be placed so that the pulling strain falls near to the direction from instep to heel, so that they pull *round* the quarter and not over the instep.

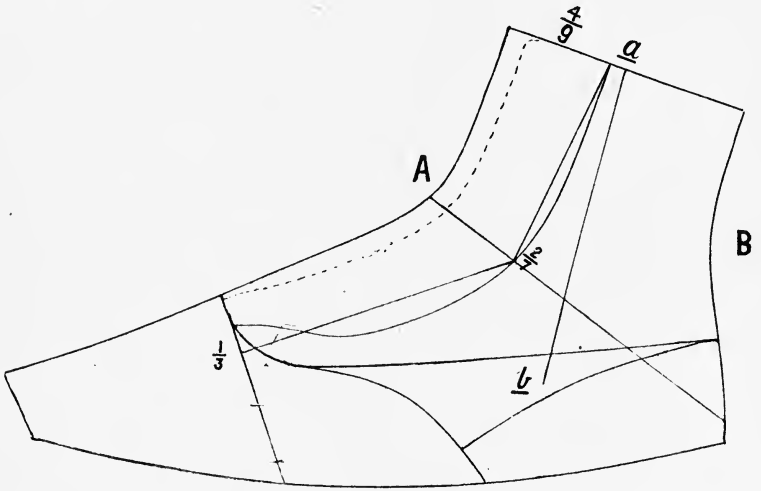

FIG. 129.

To prevent the curling of the edge of the button-piece the curve of the front seam is altered in direction, and a clinging tendency imparted by thus *springing* the button-fly

Designing the Button-piece.

After fixing the height or depth of the vamp required as A, Fig. 128, divide the joint-width A*m* into three equal parts, and at the division one-third A*m*, from A mark *n*. Divide the heel-measure line *c*B so that the distance *cp* is two-sevenths of the whole heel-measure *c*B. The top of the leg of the pattern is sub-divided so that *t* is four-ninths of the line *yz* measured from *y*. Connect *t*, *p*, and *n*. Through these points make a suitable curve to pass forming the outline of the button-piece edge (see Fig. 128). The same proportion is also shown in Fig. 129.

The curves at the throat A and the back B (Fig. 129) should not, in a button boot, be quite as sharp as in a lace boot. There are one or two ways of arranging the scollops on the outlined button-piece. They may be cut with a gouge (hand or machine), or, in better-class work, graduated. Fig. 130 shows the former scollop and method of marking out.

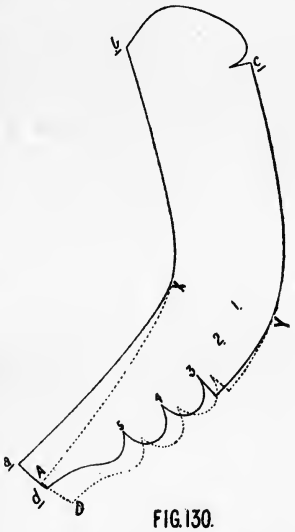

FIG. 130.

To spring the Button-piece and Scollop by Gouge.

The button-piece *abcd* (Fig. 130) is taken and outlined as shown. The amount of spring required is measured from *a* to A. A fine point is inserted at X, and the end *a* lowered to A and traced as shown by the dotted line. The tracing is continued from A to D and from D to Y. When AX*b*, *c*YD is cut out, the button-fly is said to be "sprung." To complete for gouging select a gouge and test it on the fly, and mark or cut out as shown in Fig. 130 by 1, 2, 3, 4, and 5.

The best effect is produced by arranging the scollops so that they increase in size from the bottom to the top. This graduation may be accomplished by selecting the large and small sized scollops, and sub-dividing them in proportion for the intervening scollops. The shape of the scollops selected may be circular or elliptical, the former being the easier to graduate.

Graduating Scollops (*circular*).

Fig. 131, *abcd*, shows the button-piece taken from Fig. 128. The dotted line will show the amount of "spring." The scollops may be prepared in a way similar to Fig. 132. The smallest scollop is made by means of a compass, and a line drawn at right angles

to the diameter of the semi-circle. From the centre of the first drawn semi-circle *a*, equal distances are marked at *b*, *c*, etc., continuing them to the number of scollops desired, *d*. From *d* as centre construct the semi-circle to the required size for the largest scollop. Join AD, and where it passes through the lines drawn from the equal-spaced divisions will be determined the radii of the remaining intervening scollops. These may be applied direct to the button-fly by first taking one-half of the diameter of the smaller scollops to be used, and

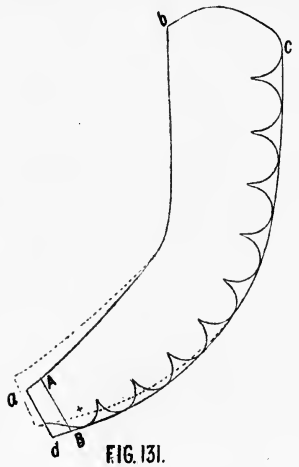

FIG. 131.

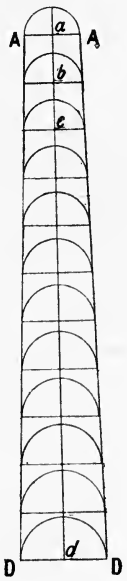

FIG. 132.

marking it from the bottom of the fly (see AB, Fig. 131). The radius of the smallest circle is now taken in the compass, and from the line AB and the edge of the fly the point of intersection X is made (Fig. 131), giving the centre from which the smallest scollop is constructed. This is repeated the whole way up the button-bit, leaving a slight space between each semi-circle to allow for the lengthening of the scollop and the clearance in cutting. When the scollops have once been graduated they may be preserved for future use by cutting out in aluminium as shown by Fig. 133.

The button-fly lining may, for economy in cutting, be

seamed, care being used not to have a seam where the button-hole is to come. If the lower portion is made to suit several sizes it enables a stock to be cut.

Scollops the reverse in principle to those shown in Fig. 132 may be used, and if they are not made too bold are adaptable to "run and turn" or "bagged" button-pieces.

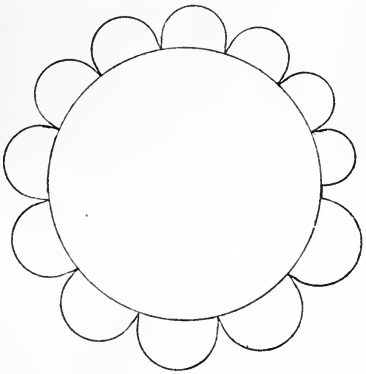

FIG. 133.

Inside and outside quarters should be made for buttoned patterns, the outside quarter having sufficient removed from the front to allow for the displacement that would be caused by the substance of the material used for the fly-lining, etc. Fig. 134 gives an illustration of this.

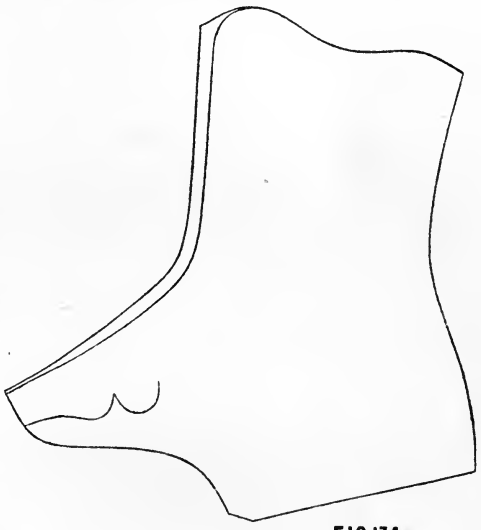

FIG. 134.

Side Lace.—The opening on the inside of a side-lace pattern should be situated about one inch from the sole edge, and should incline forward to allow the foot to be easily removed and replaced. The side lace, although not fashionable just now, is an exceedingly easy boot to wear, and is the pattern that will

exhibit the skill of the designer the most. In Fig. 129, *ab* shows the opening for a side-lace boot.

Facings.—Facings on the outside of the quarter may either be stitched or cut from a *thin* piece of leather. The former may be either plain or fancy, and Fig. 135 shows a design for facing-marker. The marker (Fig. 136) looks well on a plain-cut shoe. Inside facings will present no difficulty in cutting.

FIG. 135.

Markers for designing may be of numerous patterns. For assisting in the shaping of the curves of the standard or primary pattern they are sometimes used. Vamp curves, toe-cap outlines, golosh curves, and shapes for designing the fancy-cut vamps (usually in the common trade), are also made. Fig. 137 gives a few shapes used for fancy-cut vamps, and a scollop for a button boot.

Elastic Sides.—It was formerly considered that the cutting of an elastic-side pattern was an easy task, requiring little skill; but it is a pattern that well pays careful attention. The amount of the elasticity of the web to be used should come in for consideration, so that proper provision may be made for the width of the gusset, thus preventing the ingress and egress of the foot during use having too great a demand upon the elastic strands. The curve at the throat of the pattern must be easy and not made to resemble the pattern prevalent for lace boots. The lower curve of the gore or gusset should come below the line of the heel-measure, and be pitched forward, similar to the line *ab*, Fig. 129. This will enable the

strands of the rubber to lie in the direction of the strain that falls upon the web during the putting on and off of the boot. The front line of the spring should be at right angles with the top line of the gore. Assuming the standard from which an elastic-side pattern is to be cut correctly fits the foot, to make it adaptable to the requirements of an elastic side, one-ninth of an inch should be

FIG. 136.

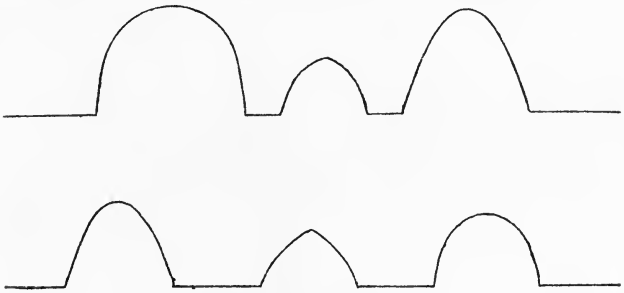

FIG. 137.

taken from the top, back and front, reducing it in measurement, giving the web an opportunity to exert its property. The principles of designing may be obtained by reference to p. 178 and Fig. 146.

Derbies.—The pattern for this style is not difficult to design, the principal points to be observed being the selection of the correct height of vamp, the width of the tab or latchet, and the shape of the corners. The substance of the material to be cut from the patterns, together with its nature, will demand variations. There are several ways of deciding the height of the vamp. A line may be drawn on the standard from toe to counter-height, and one-third of this from the toe end will locate the position of the vamp. The width of the tab on this plan may be taken as one-third of the joint-line. Another method is to make the width of tab two-fifths of the vamp when made. It should be remembered that the difficulty of the foot entering this

kind of boot is great, if due provision be not made for the passing in of the joint of the foot; and this difficulty is increased as the joint-width is greater. This will necessitate not only a correct width of tab, but a correct height of vamp.

If cutting direct to a last, the greatest width of the

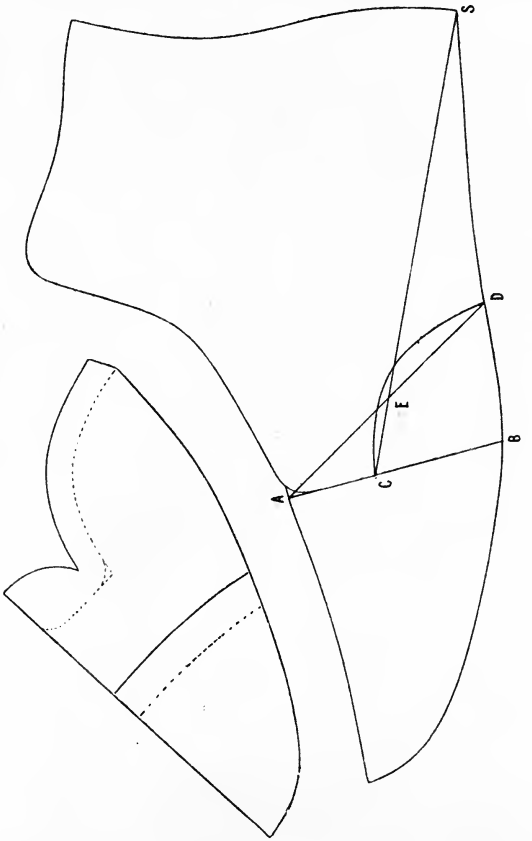

FIG. 138.

forepart should be marked on the top of the front. The vamp-height may also be obtained by adding, say, one inch to the joint table of distances given on p. 114, which will give the height when made.

Fig. 138 will illustrate a twofold method of designing

a derby, and will also show the cutting out of the vamp. The height of the vamp A is marked. A set-square is laid upon the tracing, so that one edge coincides with A and the toe end of the standard, and when in this position a line is drawn from A to B. This will ensure the tabs being square when made. The corner of the tab C is found either by taking, by means of a proportional compass, five-twelfths of A B, or may be fixed by first deciding the length of wing, which may be taken about the instep-line, or by system shown on pp. 132 and 142. Having fixed D, join A D and find the centre E. By drawing a line from S through E, until it meets AB, the position C is found. Complete as shown in Fig. 138.

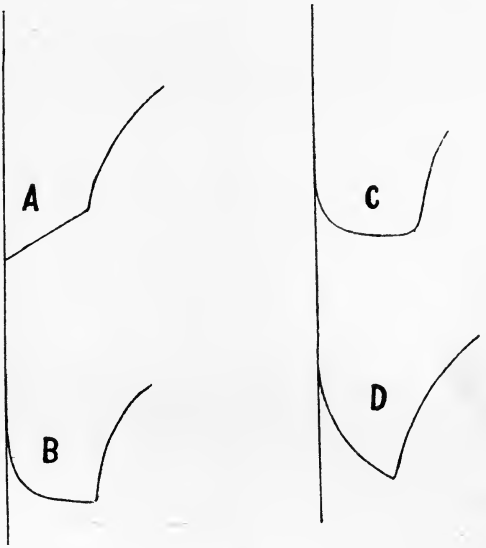

FIG. 139.

The shape of the latchet is an important factor. Fig. 139 will show several kinds. A is the style for colliers' or navvies' goods, and modified suits ladies' work. B is the usual derby tab. C is an improvement on B, the corner being slightly rounded to prevent it catching during wear. D is a bad kind of tab, the lacing when worn causing the goods to pucker. Fig. 140 shows the design for a whole-backed colliers.

A goloshed derby is designed upon the same plan, only provision must be made to allow leg or quarter to pass to

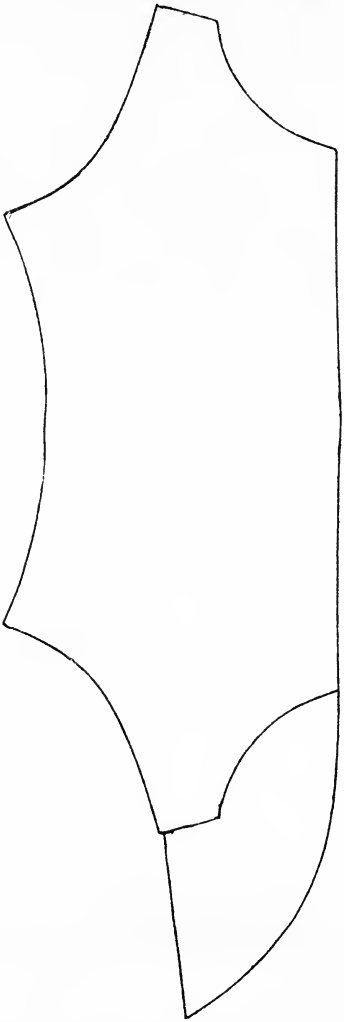

FIG. 140.

outside of vamp. If the boot is to be leather lined, due provision should be made for the stiffening to be placed between the outside and lining, because, unless the upper

be very stretchy or light, wrinkles would be found in the made-up boot. Caps may be either pointed or straight, the former giving the appearance of a narrow foot, while with the latter it would appear to be wider.

Quarter Patterns are produced from the standard with the addition of underlay; unless quarter over, a little extra should be given on the front, especially if a buttoned or similar seamed quarter, to allow for the contraction during closing. A seaming-allowance will be placed at the back of the quarter. For buttoned boots two quarters should be used inside and outside, as shown in Fig. 134. This gives a better fit to the upper, and can be put to advantage in cutting up the leather. See chapter on Cutting-out.

Lining Patterns should be made with allowances for seams, stiffeners (where necessary, such as leather linings, non-stretching materials), and for mode of making, such as sewrounds, etc. Whole-cut linings should be cut with a spring in them, to prevent foul material when made. Shoe lining should not, for comfort, have a seam at the back.

Seams, Underlays, and Lasting Allowances.

SEAMS.

Light top-band seams	$\frac{1}{32}$ inch.
Glacès, gloves, kid, etc.	$\frac{1}{16}$,,
Levants, stouter kids, calf, etc.	$\frac{1}{12}$,,
Kips, stout levants, stout calf, etc.	$\frac{1}{8}$,,
Fabrics, all kinds	$\frac{1}{4}$,,

UNDERLAYS.

Light leathers, single rows of stitching	$\frac{1}{4}$,,
,, double rows	$\frac{5}{16}$,,
Stouter leathers ,, ,,	$\frac{1}{3}$,,
,, ,, punching	$\frac{3}{8}$,,
,, derbies, punching, etc.	$\frac{1}{2}$,,

LASTING.

Sewrounds, glacès, etc.	$\frac{3}{16}$,,
,, patent, handsewn, etc.	$\frac{1}{4}$,,
,, fabrics, machine-welted foreparts	$\frac{3}{8}$,,
Machine-sewn, riveted ,, seats	$\frac{1}{2}$,,
,, ,, stouter, from	$\frac{5}{8}$,,

Discretion should be given to the nature of the leathers

to be used: a soft, yielding leather may be comfortably made with an allowance that hard, stiff, and tinny leather would not do to have.

Bespoke Patterns.—The cutting of patterns for bespoke work is usually empirically performed, and making a conformation to given measurements often is the only feature considered. There is no portion of pattern-making that requires so much discretion, thought, and care. A suitable last should be selected or made, that not only measures the requirements, but also is adaptable to the shape, etc., that is the chief cause of departure from the average. The spring or arch of the waist should be suitable for the foot, else it is difficult if not impossible to produce a good fit across the heel. This is usually one of the faults of factory-made bespoke. The excessive arch often present in these lasts throws the throat of the boot out of its correct relative position.

It would not be difficult to arrange a method or system of constructing bespoke patterns, based upon average requirements, and that would enable such variations as are required to be made to suit individual needs. It would be well here to refer to X in Fig. 39, and contrast it with another extreme type of foot illustrated by X, Fig. 40. The former foot would, if measured by the experimental apparatus shown on p. 64, register an angle of 35°, while the latter type would show an angle of 45°. These are, of course, extreme cases, but will furnish the mind with the requirements of a system that would have to cope with peculiar conditions. A foot with a high instep will have a heel-line that makes a large angle with the ground, while a low instep will have a smaller angle.

Again, the front line of the leg is more distant from a back perpendicular in a low instep than is found in a high instep (see p. 15 and Fig. 107). The heel is also, as a rule, larger in a low instep than in a higher instep of the same dimensions, and in the higher instep type of foot the ankle is thicker, and the leg and calf more developed. The

height of the ankle from the ground varies with the foot, a flat foot being nearer the ground, while the arched foot is farther away.

In making these experiments and comparing them with the last, it should be noted that in a last the waist is more arched and the comb is thinner than the foot, so that a *foot* with say, 40° heel-angle would require a last with 42° to 43°. The recording of the type of foot would be rendered comparatively easy if some practical method, similar to that illustrated in Fig. 54, could be adopted. In the absence of such facilities, the style of foot may, with a little experience, be judged from the draft-plan, if the precaution be taken of indicating the waist (see Fig. 49). The draft will assist the estimation in deciding whether the foot be narrow or broad, arched or flat. A last and pattern for a flat foot will be from 38°, the average from 40°, and the arched from 42°.

The proportions that are used to establish the system about to be described are obtained as follows. A number of lasts were taken and fitted with surface-area coverings. Upon the covers (which were tacked over) were measured the usual last proportions; the joint positions on the top of the lasts being those given on p. 114. The joint positions on the bottom were determined as shown in Fig. 60, p. 83, where J is one-third of TH (the length of the last). A line was drawn on the covers round the lasts connecting these *top* and *bottom* joint-positions. When the covers were removed and laid flat upon the cutting-board, the average angle of the joint line to the base was obtained. Similarly the toe-line was fixed by joining the end of the cover to the *last*-length, marked from the seat-end upon the base line. The table of allowances given on p. 125 were used, and an average obtained. It was also observed, in examining the relations of these surface-area coverings, that as the joint girth of the last increased, so the toe-line, when laid flat, was distanced farther from the base line, and the rule was thus obtained for fixing this point on the

pattern. To enable these *data* to be used with as little trouble as possible, a special tool has to be designed, and is illustrated in Fig. 141.

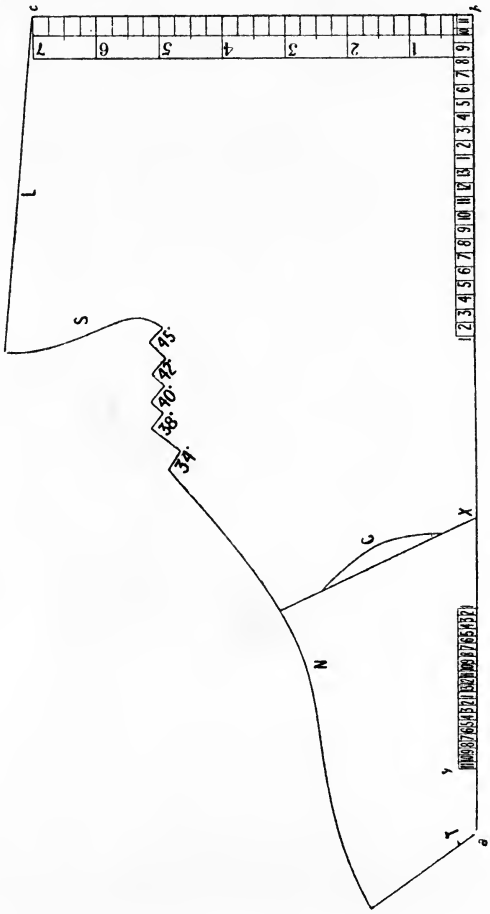

FIG. 141.

Pattern Constructor.—This tool is useful to aid the designing of a bespoke pattern, especially when the last from which the upper will be made cannot be obtained. Being based upon *average* requirements, it may also be

used when the last *is* obtainable, the additions or deductions being made to suit the special requirements.

The tool* is made of zinc, German silver, or aluminium; *ab* is 13 in. long. At right angles to this *bc* is

FIG. 142.

made, *c* being 7 in. from *b*. The distance from *b* to X is 8 in., and from X to *y* 4 in. This will make *y* equal

* It may be obtained from Messrs. Chapman & Hall.

in length, when measured from *b* to size 11 adult's last. From *b* towards X divisions of $\frac{2}{9}$ in. are made and numbered from 11 to 1, as shown in illustration. From

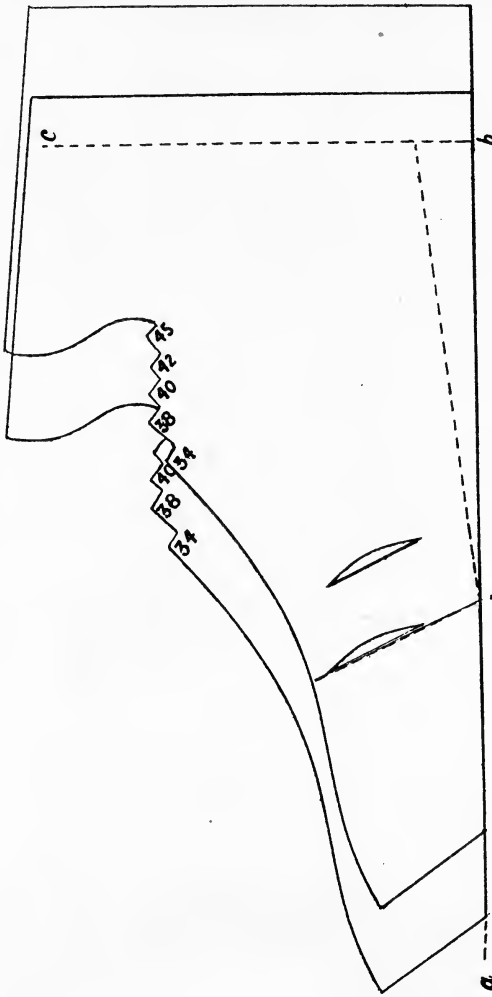

FIG. 143.

y distances of $\frac{1}{9}$ in. are made and numbered. The toe-line at *a* would make an angle of 50° with *ab* continued. T is situated one-shoe size ($\frac{1}{3}$ in.) from *a*. From T to the top is $1\frac{3}{4}$ in. The joint line from X is made at an

angle of 65° to *ab*, and $3\frac{1}{2}$ in. in length. The curve C is the shape of the throat of an upper pattern. The edge L makes an angle of 95° with *cb*, and is $5\frac{1}{4}$ in. in length. The notches 34° to 45° are cut to make the

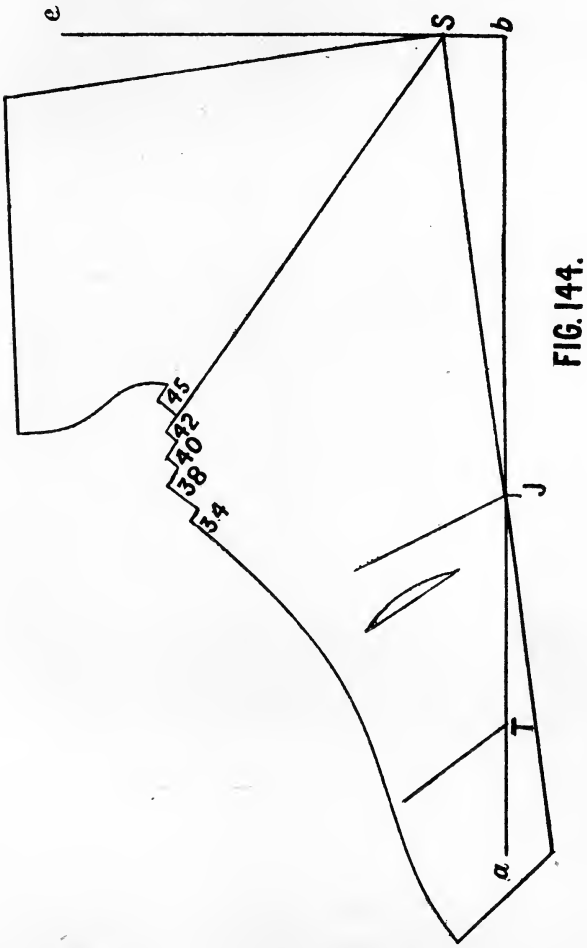

FIG. 144.

angles that they indicate to the line *ab* from *b*. The curve S is a vamp-throat curve, and N the shape of a back of an average standard (see Fig. 141).

Method of using the constructor.

Upon a suitable sheet of paper the constructor is laid, and the two lines *cb*; *ba*, are drawn at right angles (Fig. 142). From *b* the height of the heel required is measured (making deductions are previously alluded to for the thickness of the forepart). The constructor is next placed so that the adult size 8 at the back of the marker is placed on the height of the heel marked. Keeping the division 8 in this position, lower the tool until Y reaches the base line *ab*. This is letter J (Fig.

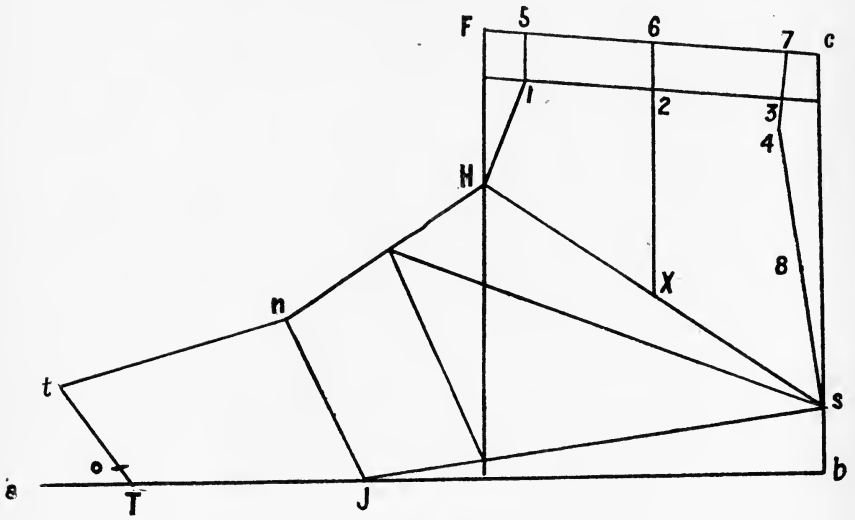

FIG. 145.

142). The tool is made to coincide at Y with J, and the back portion is lowered to the base line *ab*, and the direction of the joint line indicated Fig. 143. While in this position, the eight length is marked off from the front of the tool, and the tool moved backwards along *ab* until the bottom of the toe-line (see T, Fig. 141) is level with the 8, as shown in Fig. 143. The tool is next placed so that the corner *b* (Fig. 141) is on the height of heel position S (Fig. 144), and the base passes through J. The direction of the heel (here 42°) is marked off as shown in Fig. 144. The lines T*Jb*; J*s*;

*s*H; T*t*; J*n*; *bsc* in Fig. 145 will illustrate the stages now completed. The joint girth measure of the last, less width of the tread, is taken, and one-half marked from J to *n*. By taking one-half of J*n* and measuring it from *o*, the point *t* is obtained. From *s* the half-heel measure is marked toward H. The centre of H*s* is indicated in X. Lines perpendicular to the base *ab* are drawn through H to F, and from X to 6. From X measure towards 6 the distance XH and point 2 will be found. The top edge of the tool (L, Fig. 141) is placed

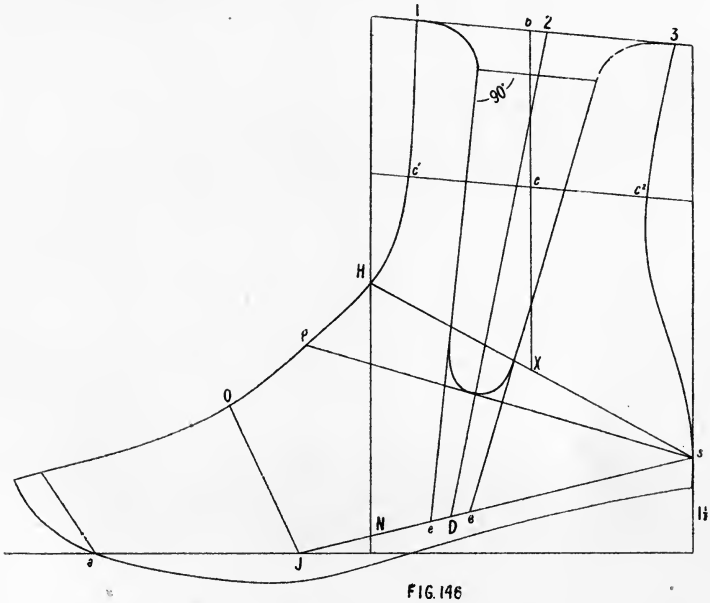

FIG. 146

on 6 (the height of pattern required) and the edge (*ab*, Fig. 141) kept level with *cb* (Fig. 145). The line F6*c* is then drawn. This is repeated at point 2, and the line 1, 2, 3 drawn. The points 1 and 3 are found by using one-fourth of the ankle-girth measurement for either side of 2. From 3 to 4 measure a constant of half an inch. Connect 4 *s*. The centre of 4 *s* is point 8. One-half either side of 6 of the leg measure will give 5 and 7 (Fig. 145). The points may be connected by straight lines, as shown in the illustration, preparatory

to the formation of the necessary curves. The instep position may be found by drawing the long-heel measure here at 34° to J*s*.

Designing an Elastic-side Pattern.—The first description will be for a ladies' size 4 pattern and for a high heel, and is illustrated in Fig. 146. The line J*s* is two-thirds (measured from *s*) of the length of a 4's last; and J*a* is the remaining third. The heel-line *s*H is made at an angle of 42° with the pitch-line *s*J. The ankle is found as

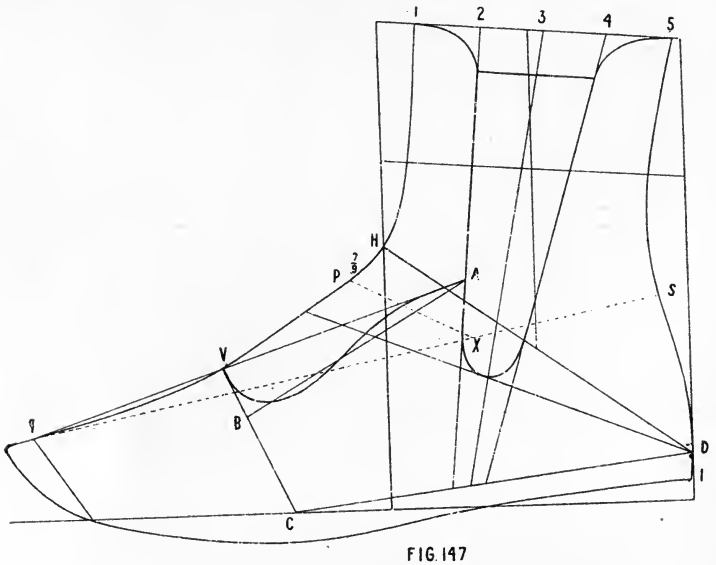

FIG. 147

described in the previous paragraph, also the top of the leg, except that it is made $\frac{1}{9}$ in. less at the back and front than the measurement of one-fourth of the *leg* measure. After the measurements of joint heel, etc., have been made, the points thus located should be connected with proper curves, and the outline obtained, as shown in the illustration. The top of the leg 1, 3 is divided into four parts (refer to 2, 3, 4 in Fig. 147). The line from N to *s* is also divided into four equal parts, and N to D is one of these. To obtain the centre of the gusset connect 2 with D. On

either side of D mark $\frac{3}{9}$ in. and obtain *ee*.* By joining *ee* with the sub-divisions of the top of the leg, the gore-line will be shown. To obtain the position of the bottom of the crescent, connect P, which is the centre of HO, with *s*, and where it crosses the line that passes from 2 to D is the correct position. The diagram will explain the remainder of this pattern. Fig. 147 shows an elastic pattern for a lower heel, and the difference in curve and position should be noted. The illustration also includes the designing of a garibaldi and shoe upon this system. The height of the front is regulated by V. The top of the line T is connected with V by a straight line which passes to A. This line represents the fold or crease line of the vamp. Make a line from A to B, and this will give a guide in making the curve shown. B is found by taking one-third of VC.

Shoes.—A shoe may be produced upon this plan by making S the height required,† and connecting this with T, as shown in the dotted line. P is $\frac{7}{9}$ of an inch below H. A line passing from P to D gives, where it crosses the line TS, the point *x*. The curve of the top of the shoe may be completed in the usual way. To find the length of wing of the vamp, take one inch from the half of CD, in the direction of C, and proceed as Fig. 120.

Grading.—After the initial or standard pattern has been produced, a *set* or series of patterns have to be made. Every pattern in the set must reproduce the features of the standard, and in measurement be adaptable to the lasts or scale of measures for which the set is intended. The method selected to do this should be simple, yet adaptable to the various needs of the trade. In scaling or grading, the various parts of the standard such as vamps, etc., the difference between the length-line of the last and the distance round the last should be fully

* If men's work, mark $\frac{4}{9}$ in each side of the gusset central line.

† Seven-ninths of an inch *over* one-fifth of the instep girth is recommended.

understood. The length of the last, on the size-stick plan, is measured by taking the shortest distance through the last, and in grading parts the ratio of the part to the original or standard last should be strictly maintained. If an imaginary cut be made through the last, then the relation of the proportion to the length of the last, or the distance round, may be remembered by noting that parts measured in their entirety on this imaginary axial line must be proportioned to the length of the last. Parts that start on the axial line, but do not continue throughout their length, should be ratioed to the length of the standard pattern, which represents the distance round the last. This is an important point to study if the desire be to make the shoes or boots made from the patterns graded, like the original or standard boot cut from the standard pattern. The diagram, Fig. 148, will assist the understanding of this point. The line AB is the length-line of the last, and therefore from what has been said it follows that the vamp-height or depth CD, and the golosh depth EF, would be regulated by the proportion it is of the line AB. The vamp-wing V would, on the other hand, be

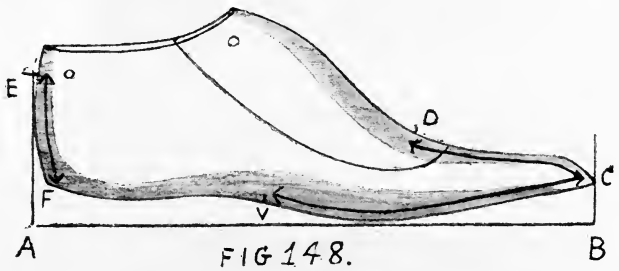

FIG 148.

ratioed not by the length-line AB, but by the distance *round* the last from A to B, corresponding to the length of the standard pattern without the lasting over allowance. To put the parts affected in tabular form, it would be—

Proportioned by the Last Length.	Proportioned by the Standard Length.
Vamp depths.	Wing lengths (vamp and cap).
Toe-cap depths.	Stiffeners (lengths).
Stiffeners (depths).	Back goloshes (lengths).
Back goloshes (depths).	Shoe openings.
Shoe heights at back.	

The great obstacle to regular gradation in the upper patterns is the irregular last-measurements in use in many factories. The breaks between some of the sizes already alluded to, require the calculation of the cutter. For instance, if the grading of the heel girth according to one of these irregular scales of measurements be attempted, modifications in grade of $\frac{3}{8}$ of an inch between the size 5 men's and the same size in youths', would be $\frac{1}{4}$ in. The grade would then be $\frac{3}{16}$ as far as the size 2, it being $\frac{1}{8}$ less at this break.

There are many methods in use in the trade; many of them do not give correct results, while others are so empirical that they depend entirely upon the user for any apparent results obtained. Before examining some of them, it will be well to understand what grade should be selected for the various parts of the pattern. Suppose the lasts on a small range of sizes increase $\frac{1}{4}$ of an inch between the joint and instep girths, and that the tread or bottom width increases $\frac{1}{12}$ and the waist $\frac{1}{16}$, then to obtain the grade for the upper portion of the pattern it should be arranged as follows:—

	Joint.	Instep.
Total grade of last at	$\frac{1}{4}$ in. ...	$\frac{1}{4}$ in.
Total grade of sole at	$\frac{1}{12}$ „ ...	$\frac{1}{16}$ „
Increase to upper portion	$\frac{2}{12}$ „ ...	$\frac{3}{16}$ „
Increase to the pattern	$\frac{1}{12}$ „ ...	$\frac{2}{32}$ „

With half a size to the heel girth and $\frac{1}{9}$ to the ankle, and $\frac{1}{8}$ to the top of the leg. For other dimensions proceed in like manner.

The Comparative System of grading is useful in supplying patterns to complete those already in existence that have some part or other missing. It is also adaptable to obtain

a set of patterns to suit the many variations of lasts from a standard scale of measurements that are found in some establishments. It is a system suitable for scaling children's patterns if used in conjunction with some such system as that illustrated in Fig. 146 or 147; it is a very good method of grading patterns, but is usually discarded in favour of some other system, owing to the difficulty experienced in obtaining two patterns exactly alike in general character.

Modus operandi.

After the two standards, quarters, vamps, or other parts have been obtained, lay them on a sheet of suitable paper to make a *stencil*—marking the largest pattern first. After the larger pattern has been marked out, put the smaller one in such a position as to be readily distinguished from the one first marked, and trace that also round as shown in Fig. 149. Similar points on the two patterns must now be connected with lines. If the positions of taking the measures be marked on the two standards, this will not afford any difficulty. If the grading be for two parts, such as WXYZ in Fig. 149, then the corners should be connected as shown, producing them as *x*XO and *z*ZO, meeting in point O. The point of intersection will give the centre for making radial lines for the whole of the back *x* to *z*. In a similar way the centre is found for the curve between *w* and *y*. After the lines are joined that may be considered sufficient for the purpose, the distances between the same positions on the two patterns will be sub-divided into as many equal parts as there are sizes intervening. See X*x*, Fig. 149; also *t*T in the same figure.

The One-Sixteenth System of grading is supposed to be a system whereby a sixteenth of an inch is put round the pattern, leaving the extra on the toe to make the necessary addition to the pattern's length. When cutting out, the various alterations are made to make it approximately correct by keeping the knife either to the outside of the line or by cutting under where the increase is too great.

It depends, therefore, upon the individual judgment of the user, and is on this account to be depreciated. To obviate

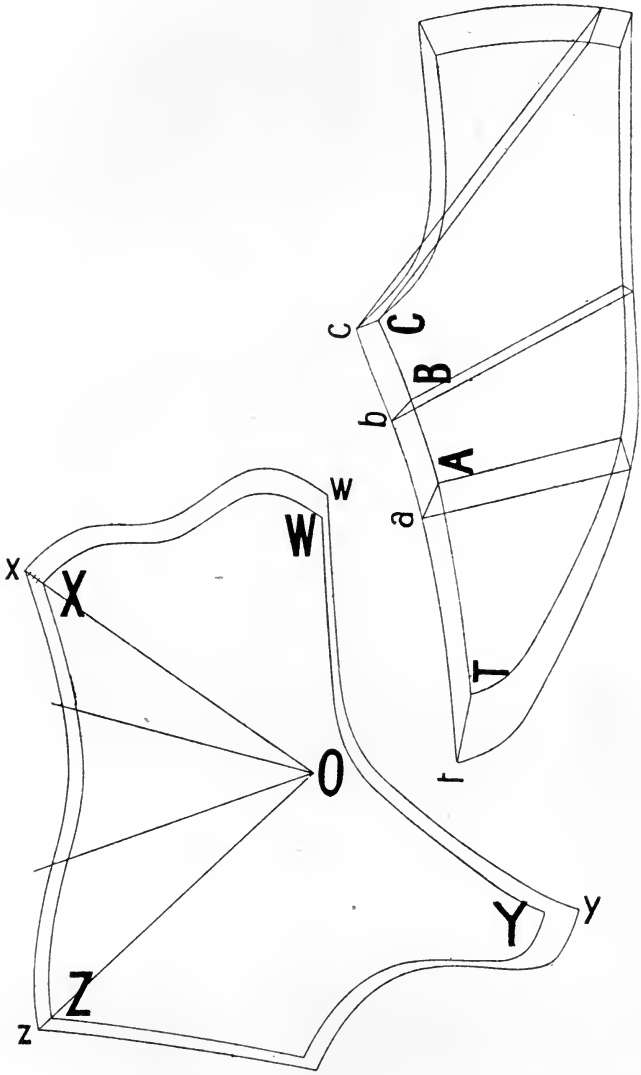

FIG. 149.

this leaving-on and taking-off business, several modifications have been and are used, one of which consists in using

spring dividers set to distances of $\frac{1}{16}$, $\frac{13}{48}$, $\frac{5}{48}$. This will be for the data: one size in length, $\frac{1}{4}$ in. girth, and the ankle being equal to the joint.

Method.

Take the compass set to $\frac{1}{16}$, and from the top of the leg with this distance mark as far as the throat; at the throat mark with the other compass $\frac{5}{48}$. From the throat to the toe mark $\frac{1}{16}$. Put $\frac{1}{16}$ along the top, down the back, and along the bottom. Leave $\frac{13}{48}$ at the toe.

The sixteenth system leaves the patterns the same length from the top of the leg to the throat, giving the patterns a stumpy appearance for the large sizes, while the smaller sizes look too long. The joints are also out of position, and the instep does not alter its position for the various sizes. This error is known among many of the users of the system, and it is defeated by various means, one of which is given under.

Take $\frac{1}{16}$ in. in the compasses and mark up the front, along the top, down the back, and from the seat to the joint. Add one size less $\frac{1}{16}$ to the toe of the graded standard. Join toe to the joint. Place standard pattern half size away from toe of the newly marked one and correct the joints. Raise the standard $\frac{1}{32}$ at the seat from the marked seat and mark the back, or $\frac{1}{64}$ is left on the swell above the counter. Leave $\frac{1}{64}$ from the top of the instep to throat, graduating to the front of the leg. Leave $\frac{1}{32}$ on the front of the leg, and if the top be curved or volute leave $\frac{1}{32}$ on the front curve and $\frac{1}{32}$ in front of the back curve.

The One-Fifteenth System is very similar to the one described, and it consists in taking one-fifth of a size ($\frac{1}{15}$ in.) in the compasses and then marking that amount round the top, back, bottom, and up the front. Add one size less $\frac{1}{15}$ in. to the toe, correcting the joints in a way similar to the one described above.

To grade vamps on these systems make a line $\frac{1}{16}$

from a folded piece of paper, and mark $\frac{1}{9}$ at the right-hand end. Take the vamp to be graded and put the front level with the $\frac{1}{8}$ mark, while the toe is level with the crease of the paper, then lower the throat of the vamp $\frac{1}{16}$ and mark the half-wing. Put half-size to the length of the wing and complete the curve, using the standard to get the bottom portion.

There are many **Shifting Systems** of grading in use in different localities being employed by the empiric.

> In the first method the curves of the pattern are marked upon the standard at each centre, and a line ruled from the toe to the counter. The pattern is then taken and traced on a sheet of paper, and the line from the counter drawn as in the standard. One-ninth of an inch is added at the heel end of the toe-counter line, and $\frac{2}{9}$ in. at the toe end. The grade used is $\frac{1}{9}$ at the joints, $\frac{5}{36}$ at the instep, $\frac{1}{6}$ at the heel, and $\frac{1}{9}$ at the ankle. These amounts are divided and placed to the credit of the respective parts. The pattern is completed by using the standard to connect the various points.

Hannibal's is another type of shifting system, and is described in his work upon "Last Fitting and Pattern Cutting" something as follows:—

> The standard pattern is taken and lines ruled upon it at the joints, toes, instep, heel, and ankle. A line is also drawn from counter to toe. On this horizontal line from the toe two separate $\frac{1}{9}$ in. are marked. From the toe end $\frac{1}{4}$ in. is also marked. The standard is now placed upon a suitable sheet of paper, and the three dots in the standard marked through on the paper. While the standard is in this position mark round as far as the toe-line top and bottom. Shift the pattern towards the heel, so that the first dot on the paper is visible, and while doing this lower the back until the toe at the first mark is level with the traced outline. When in this position mark from the top of the toe-line to the joint. Now shift the standard until the second dot appears, lowering the back until the first on the toe

touches the traced line. Mark from joint to instep. Again shift the standard until the third dot appears. While in this position mark from the instep to the top of the leg. Trace also the top. Shift again until $\frac{1}{12}$ in. is shown from the throat to the top of the leg. Trace down the back as far as the ankle, then lower the standard, trace the back as far as the horizontal line. Lower the standard until the distance of $\frac{1}{8}$ in. is shown at the instep, keeping the toe in line with the toe of the traced outline. Mark the bottom to the instep. Shift the pattern to the second dot and trace from instep to joint. Cut out if satisfactory.

The Geometrical System is practised under several names —such as the Proportional, Radial, Parallel Rule, Tool, Set-Square, Sector, Proportional-Compass, etc.—but in principle is the same. The same results exactly are produced by all these instruments, and it corresponds also to the result derived from the grading machine described on pp. 99 to 101, if the width adjustments be set to zero. The mathematical truth * underlying this method should be understood, enabling the system to be adapted to many operations with intelligence. Patterns graded upon the geometric or proportional systems have all the parts scaled in true proportion. If the ratio of the joint, instep, heel, ankle, leg, height, etc., be expressed in terms of the length-line, then all the patterns produced upon the methods above alluded to will be in precisely the same ratio. In other words, the amount of grade is always in the same ratio to the length-unit increase, as the proportion existing between the length and the portion graded. From this it will be readily deduced that the larger the fitting of the pattern the greater the grade. But this does not conform to trade custom, where the same unit of grade is supposed to be used for all fittings. The patterns graded upon the proportional system in its strict application is usually found to be in error from the lasts at the instep; and the top of the

* The demonstration of this theorem will be found in the sixth book of Euclid and the sixth proposition.

leg is scaled in a different unit than is customarily adopted. The positions at which the various measurements are taken are also graded in true proportion to the length and the length-unit used. The application of the system may be understood by taking an example, with a standard of an upper.

Take the standard from which it is desired to grade a set on the geometric method, and trace its outline with

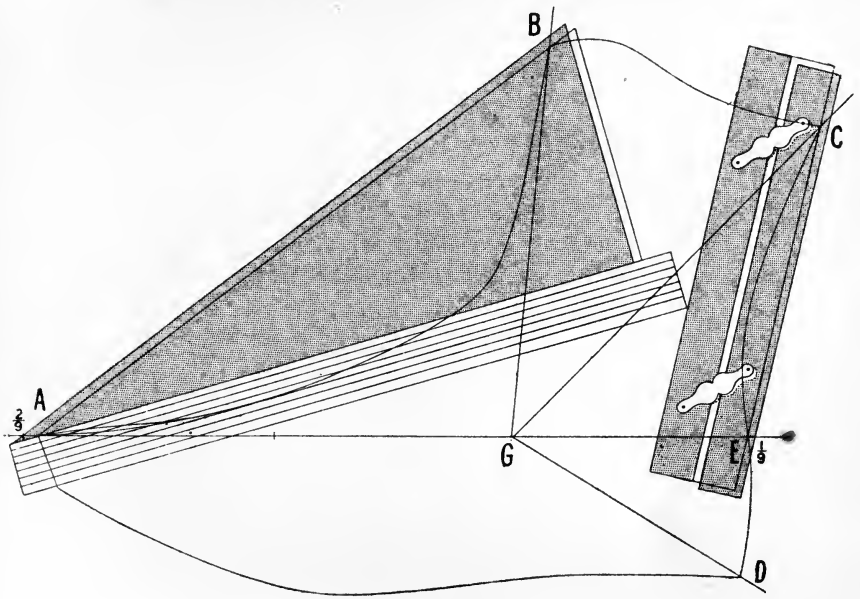

FIG. 150.

a fine line on a sheet of paper as Fig. 150, where A, B, C, D is the pattern. Make a line from the *counter-height* E, towards the toe of the standard A, continuing it a sufficient length beyond the pattern to mark thereon the number of sizes that are required in grade. A central radial point is now to be found, and in principle it matters little where the point is placed; but for convenience it is best to make it some fractional part of the line AE, and the point selected should also be convenient to cut as many of the curves of the pattern as

sharply as possible. This will usually be attained by selecting the point one-third of the length AE from E (see G, Fig. 150). A shoe size (if English measures, then $\frac{1}{3}$ in.) is to be divided into the same proportion as the toe-counter line, and the subdivisions placed outside of E and A, repeating them for the other sizes required. In Fig. 150 the amount placed to the credit of E, for each size is $\frac{1}{9}$ in., and at A $\frac{2}{9}$ in., making $\frac{1}{3}$ in. for the whole increase. A radial tool should now be constructed to compare results with what has been done. This *radial tool* is made as follows: A line AE (Fig. 151) is drawn on a separate piece of paper, equal in length to the line from the toe to the counter of the standard for which it is intended. At one end, say A, a line A*a* is drawn at right angles to AE. From A, in the direction of *a*, mark as many shoe sizes as are required, 1, 2, 3, etc. Connect these points with E, as illustrated, and when the paper has been cut to the lines 3E, EA, and

FIG. 151.

A*a*, it is ready for use. To use, put the end E at the radial centre G, in Fig. 150, and lay the edge AE of the tool level with the line AE. Where the toe, A, crosses at H (Fig. 151), H*h* gives the grade from A (Fig. 150).

Lines radiating from G will be drawn through the principal points desired to be graded (see Fig. 150, GB, GC, GD, etc.). If continuing to use the radial tool, the end E of it should be placed upon the radial centre G, and where the base-line crosses the radial-line at the portion of the pattern to be graded, the transverse distance of the tool will give the amount of grade.

If the pattern be prepared as described above, and the amount of proportional grade be marked from the points AE, as shown in Fig. 150, the remaining points may be found without using or making the radial tool. After the radiating lines have been drawn from the centre G to the various points required, a *set-square*

may be used to obtain the grade at B, C, D, etc. Place one side of the set-square to two points* of the pattern, such as AB (Fig. 150), and while in this relation put a straight-edge to one other convenient side of the set square, as shown in Fig. 150. Firmly hold the straight-edge to the paper, and slide the set-square—keeping it to the straight-edge — until one of the graded divisions at A is reached. Then, where the set-square crosses the radial line from B, the new amount of grade is found.

Instead of the set-square a *parallel rule* may be employed. One edge of the rule should be laid to the points, such as C and E in Fig. 150, and the fingers put firmly on the bottom portion of the rule to keep it from moving; the top half of the rule to be carefully moved to the point already found, and the required grade will be given.

A *sector* will give the same results exactly as the parallel rule, the set-square, or the radial tool, but it is not so convenient to use.

The *proportional compass*, illustrated by Fig. 152, is a very useful instrument to the pattern cutter, and can be applied here to grade the amounts for the method illustrated in Fig. 150. If a compass of 6 in. be used, it will be necessary to divide the line AE into two

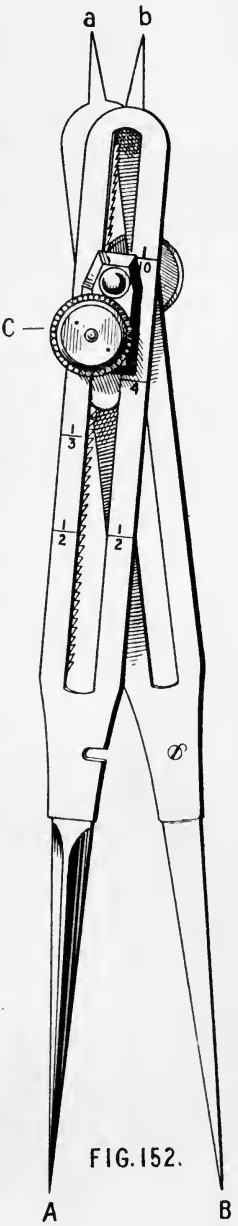

FIG. 152.

* One of the points used each time must have the grade previously marked or found, otherwise *any* two points may be used.

equal parts, instead of the usual three. But if a pair of compasses of larger size be used, it will not be necessary to depart from the rule laid down. Take the compass and loosen the nut C, and by trial remove it until the distance between the legs AB is equal to the length of the standard AE (Fig. 150), and at the same time the legs *ab* shall span the number of sizes to be graded. The nut should then be fastened rather tightly. The legs AB are then made to span any radial line, say as GA (Fig. 150), and by using the other legs *ab*, the required grade is found.

The adapted System is founded upon the geometrical method, but is adapted to the various trade measurements used, while it retains the regularity of appearance, and conforms to the lasts. If it be thoroughly understood, it can be used for any unit grade, English or foreign, and for sets of lasts that have breaks in them, it is a very valuable method of grading. A method of locating the positions of measurements should be adopted, such as the one described on p. 114, or, better still, a table made from the positions located from the back on the size-stick principle. This will prevent the measurement of different places on the last and on the pattern. The positions of the toes, joints, instep, heel, ankle, and leg being indicated on the standard about to be graded, then the following mode will be used:—

Carefully mark round the standard upon a suitable sheet of paper an outline of the pattern to be graded, making the lines across as recommended, that have been previously taken from the last. For accuracy in this method it is imperative that the positions of measurement on the pattern and the last are identical, even if it be not to a table of location-distances. Select a suitable point as centre (which is usually either the seat of the pattern or the counter-height line), and from this point draw radial lines; * in Fig. 153 will be the point selected for the present description. From this point * draw the line * A*a*, and from the central radial point also make the line to C. From A mark either side as many sizes as

you wish to grade above or below the standard size. At right angles to the base-line * A*a* make lines meeting the line terminating in C. This will determine the length of the other sized standards. In the illustration the cross lines at the toes, joints, instep, etc., have been omitted, to make the plan clearer. The *positions* of the other lines, toes, joints, etc., are now to be found. They are obtained in the same way as those described for the

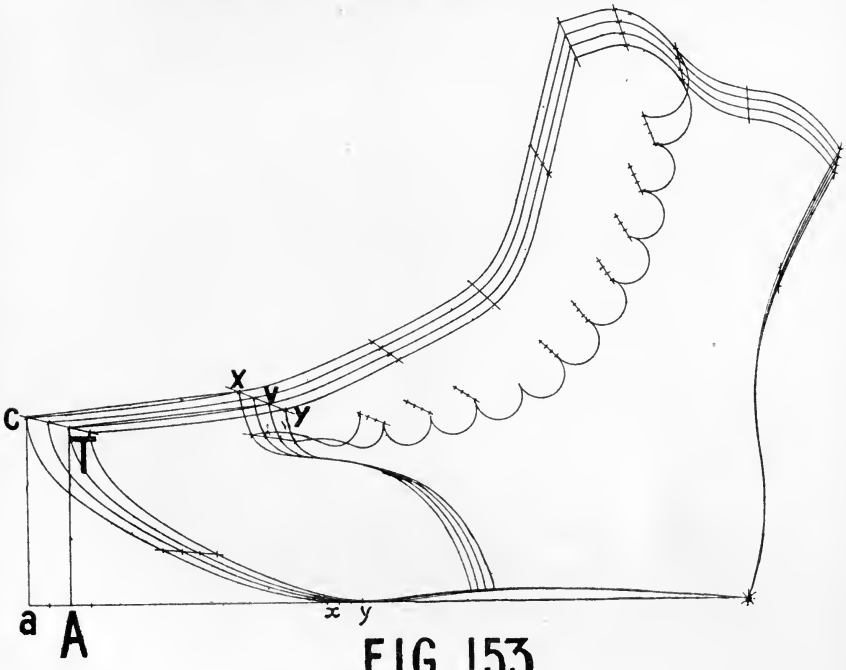

FIG. 153.

geometrical system of grading. The widths are determined by taking them direct from the lasts, or from the scale, if working to a scale. In Fig. 153 X has been measured from *x* on the position-line found by the geometric. Y has also been got from the last. The instep, heel, ankle, top of leg, and height of standard have also been obtained in the same way. The grading of the parts may be done on the same stencil as the standard. They must be graded so as to produce the

same appearance and proportion as the original boot possessed. This has been alluded to on p. 180, and also illustrated on p. 91. The grading of the vamp on this method has been demonstrated in Fig. 153, where VT is the line of the front of the vamp of the standard. Through the height of vamp (which has been obtained as recommended) a line from X is drawn parallel to the *crease-line* of the *standard* vamp. Any other parts are obtained in the same way.

Some Errors in Patterns, and how Remedied.—An error often made in the cutting of patterns is that the toe of the pattern is sprung too much for the last. This makes the front seam curve shorter than that suitable, and by some is supposed to assist the laster in producing a better draft. It is, however, a false idea. It certainly imparts in the made-up boot a tension throughout the depth of the vamp, but it adds to the troubles of the laster in dealing with the upper round the feather, and if the material lasted be something of the nature of patent, it will be a matter of extreme difficulty to get a clearly lasted feather.

If the toe of the pattern be made *dead*, it reverses to an extent the effect of the previous error. The front seam is lengthened, the edge of the upper along the bottom is shortened, very often made so short that the waist is tight in lasting, and the linings do not sit clear when off the last. Another error often practised is the straightening of the front curve above the vamp. This throws a strain upon the front seam, but does not increase the length of the bottom edge of the upper when lasting. If not overdone, however, it is a useful way of remedying the falling in of the vamp or the front of the golosh caused through the curve being too sharp down the front of the pattern. Blocked fronted goods are often cut too acute in the front curve of the rounding and blocking pattern, and when this is the case, it may be remedied by adopting in a moderate way this practice of straightening the front curve. Shoe patterns are often curved at the top of the back quarter

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seam, with the idea of assisting the clipping properties. It is liable to cause a strain on the seam and to gall the foot of the wearer. Curves for the side seams of slippers, and the seams such as those used in wellingtons, are often spoilt by not applying the principle of rounding or curving the seams according to the nature of the material. Patterns cut to *formes* produced on Soules or the mitre methods are often found to be too springy at the toe, and the front seam is too short, owing to the neglect of not making allowances for the openings of the slits when on the last. For instance, in Fig. 120, VN is correct, but TV is too springy, while for patent leathers the corner of the forme would be relatively more suitable. The tongues of such designs as the "Langtries" are usually too baggy, and this should be remedied by the use of the curved seam principle. It is often termed "draft." * Strap or bar shoes are often cut to pull across the instep rather than round the foot, somewhat in the direction of the heel-line. Lining patterns are very faulty in their allowance for stiffenings. The substance of the cover, its stretchiness, and the mode of making have to be fully weighed and allowed for. In the made-up boot very often the vamps, toecaps, etc., of the larger sizes look out of all proportion to the original sized boot, and this may be prevented by remembering that the relation of the parts of the made-up boot that are measured throughout their entire length on the imaginary axial line of the boot are proportioned to the length of the boot, while the wing and other portions that are not so measured are proportioned in relation to the distance round the last.

Long Work.—The cutting of long-work patterns is supposed to be a special branch of pattern cutting requiring special skill. There is not so much variation in the style and shapes of long work as in short work, and when the initial difficulties are overcome, the rest is not so difficult

* It is advisable to use the term "draft" to apply only to the property of the lasted boot, and to use the term "spring" to describe the principle here alluded to.

as it would appear to the uninitiated on first inspection. The modes of cutting the various kinds of long boots may be illustrated by describing the Field, Butcher, Coachman's, Regulation, Wellington, and Dress Wellington. The bespoke houses are not so particular in the cutting of the pattern as would be deemed necessary for the factory, where they may be made machine-sewn or welted. In the former case the closer practically shapes the upper. The mistake made by those who have only cut short work, when cutting long work for the first time, is to neglect to provide for the passage of the heel portion of the foot into the made-up boot. Then the opposite extreme is resorted to, and the boot fails to fit in the heel, causing a sloppiness during the wear. Attention in cutting this class of work should be given to the throat, so that it may not be too sharp, and out of its correct position in relation to the last.

Elcho, Field, or Sportsman's.

One method to cut the pattern for this style of boot is to draw a line, and at one end erect a perpendicular. Up this the height of heel desired is marked. The counter-height (taken from such a scale as given on p. 138) is next measured from the seat. The last is taken and laid, so that the back touches the counter-height, and, at the same time, the joints and seat of the last are made to coincide with the correct marks on the paper. While the last is in this position, the positions of the places of measurement are marked and the outline traced. The front *position*-line is obtained by taking one-half of the last's length, and marking it along the base-line from the perpendicular. The ankle is made about an inch in excess of that obtained by measuring the foot. This is to allow for the thickness of the tongue, etc. The heel allowance requires enough for the amount taken by the tongue and the substance of the lining and stiffening, as well as for the shape of the last at the seat. The top is made about a half of an inch smaller than the calf.

The pattern may be constructed by the "Pattern Constructor" shown by Fig. 141. The mode of using

this tool will be understood by referring to Figs. 142, 143, 144, 145, 146, and 147. The height of this design is about 15 or 16 in., for, say, a size seven. In Fig. 154 this style is illustrated. The unnecessary preliminary construction lines have been omitted for the sake of clearness. AB is the heel-line and CD the calf. A four-fold tongue is needed for this design. The inclination

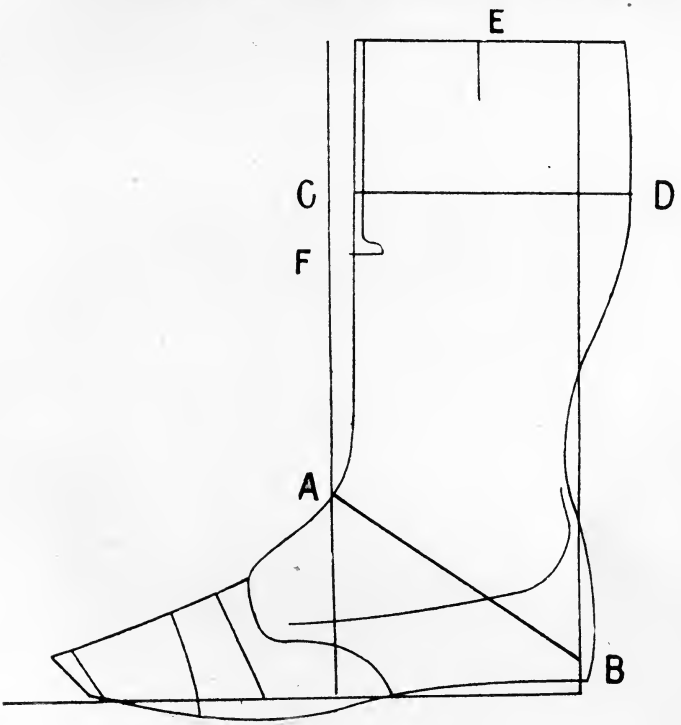

Fig. 154.

will be varied as to the kind of making-system, or want of one, adopted. This boot may be cut with a whole golosh or vamp and quarter. Care should be taken not to make the opening too low down the leg of the pattern, the rule being that from F in Fig. 154 to the other side of the leg below D, the distance should not be less than the heel-measure. A buckle and strap is used to fasten

the opening at E, which has a gusset-tongue on the inside. It is well to incline the top forward to allow the boot to assume an upright position at the top when made.

Wellington.

The fronts are usually purchased ready blocked, and it is customary to apply the measures direct to the leather front. From the throat one-half of the heel

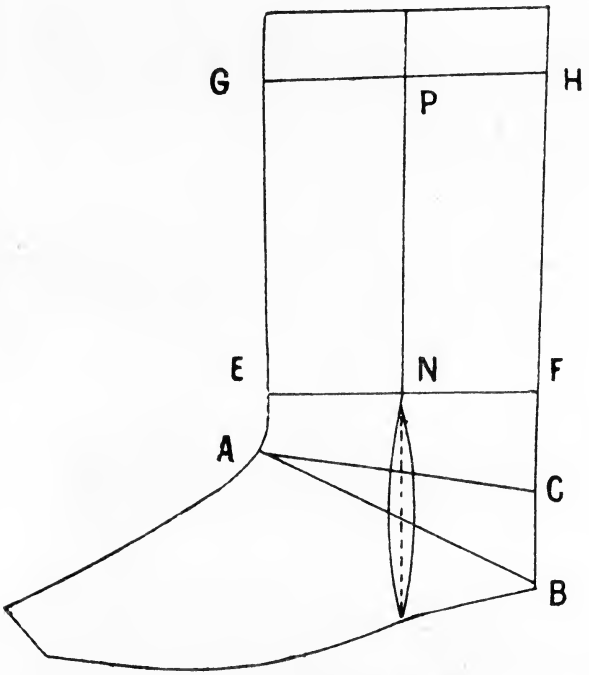

Fig. 155.

measure is marked in the direction of the seat. At the top one-half of the calf measurement is placed; this is joined with a straight cut. At a distance of $2\frac{1}{4}$ in. from the bottom, make a curved line some distance of $\frac{3}{16}$ in. The height is about 13 to 14 for a seven's. Another way of proceeding is illustrated in Fig. 155, where AB is made the full heel-measure and AC some

$\frac{3}{4}$ in. less. EF is made the same as the heel-measure. GH is the calf, the centre being P. EF is distanced some 5 ins. from the bottom. The amount taken out from the straight-cut line is about $\frac{1}{4}$ in. for stouter materials and $\frac{5}{16}$ in. for lighter. The cutting of a dress wellington will not be difficult, when a wellington can be properly cut. Fig. 156 gives a made-up long boot (a dress wellington), and will show what is the correct position of the leg. The side seam must be straight when made.

FIG. 156.

Butcher.

This, and the coachman and jockey, are made from 15 to 16 in. high, and are nearly the same in design. They may be designed by making a line on a suitable sheet of paper, and at one end erecting a line at right angles to the first drawn line. One-half of the length of the last is measured from this upright line, and at this point a line is made at right angles to the base. The height of the intended boot is now determined, and a line drawn for the top edge of the pattern. The calf measure is now applied to the position given from the measure. If this position be omitted, a good rule is to place it at a distance equal to the full heel-measure of the case under consideration. The heel measurement, with suitable allowances for the counter, etc., is taken, and one-half of it applied to the tracing. The pattern is now made to measure from the throat to the back, so that the point 5 in. from the seat is the same in measurement from the throat curve as the heel-measure. The counter is made about 3 in. long and $2\frac{1}{4}$ high. The calf requires adapting in measurement to the needs of the case, as a measure taken over the trousers does not demand any allowance as would be the case with a measurement taken round

the naked leg. The difference will be about from three-quarters to an inch.

Another way of producing this kind of design would be to use the method illustrated by Figs. 141, 142, 143, to 147. A couple of lines are made at right angles to each other. From X the usual height of heel is marked to obtain the seat of the pattern (B, Fig. 157). Often an

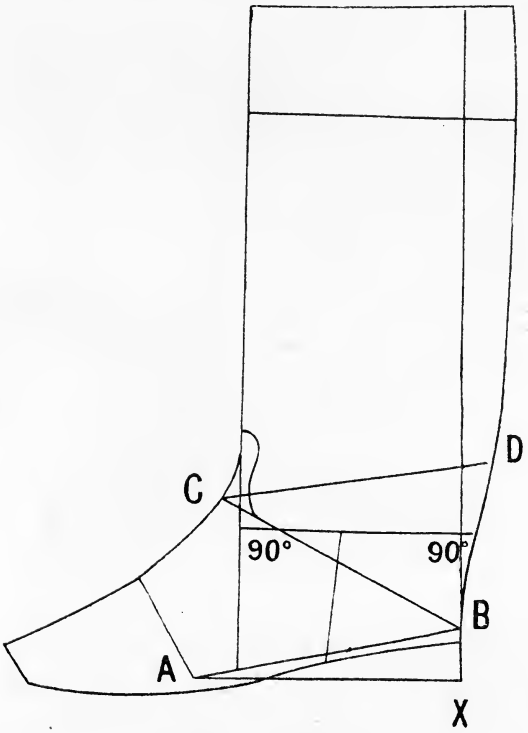

FIG. 157.

allowance is made here for the kind of lasting—hand-sewn or machine—so that the position of leg in making may be easily obtained. The pitch-line BA is drawn either with the pattern constructor (Fig. 141) or by making it two-thirds of the length of the last, which the pattern is supposed to be for. At A the joint-line is

drawn from the tool (Fig. 141), and then the toe-line made as recommended on p. 176. The heel-line BC is made at a suitable angle to the *pitch-line* BA. BC is made of a length that represents the heel measurement, with the necessary allowances for the counter, etc. CD is drawn at an angle equal to that demanded for the kind of foot and represented by the angle ABC; so that the angles ABC and BCD are equal. When this is the case the line CD is made equal to the heel-measure. The throat of the tongue should be easy in curvature. The coachman or jockey has a top that is not shown in the illustration. It is made from 5 to $5\frac{3}{4}$ in. in depth and 1 in. higher than the leg to allow for turning over. It must be wide enough to allow for seam, and going over the leg so as not to cause the latter to wrinkle. The shape of the tongue is made fancy for the jockey top.

Regulation.

By way of a variety, and to show another way of cutting long work, the system, for this kind described, will be based upon the one given for short work, viz. system No. 3, p. 133. The distance of the front of the boot from the line that passes through the throat point should be less than the half-inch allowance for short work. This is owing to the forward position of the top of the leg of the foot, the substance of the leather, and its closed nature down the front. A *forme* is used for fitting the last (it should be remarked also that the last from which this forme is produced should be previously "fitted up" to the heel-measure of the foot in its right *position*) as in the method on p. 133. After the *forme* has been outlined and the base-line drawn (CD, Fig. 158), two upright lines are drawn at the extremity of the toe, and counter of the *forme*. The line CD is divided into four parts, and A is the position of the line AB. The calf is marked, and the height of the top (which in this regulation boot is 15 to 16 in. at the back and from 16 to 17 in. at the front) and the heel-measure, etc., arranged. F is distanced from E the same as the length from O to X. Then XF is the same as the heel-measure. If the boot is intended to bellows or fold, then allowance should be made for it—some two or more inches.

It should be noted that the idea of making the leg of a long boot the same as the heel, so as to allow the heel to pass, is usually all that is considered sufficient, whereas the height of the foot at the throat, from the ground, affects the passage of the foot in the boot. By making the line CD in Fig. 157 at an angle to the line CB, as

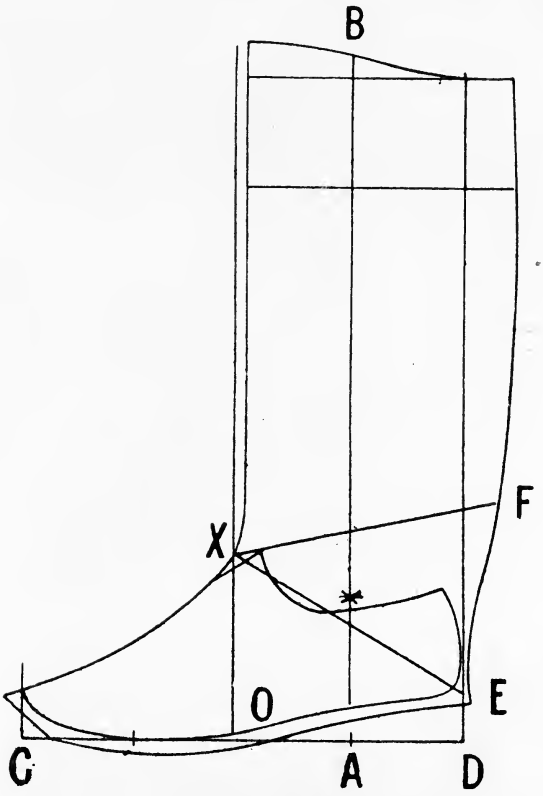

FIG. 158.

CB is to AB, the clearance for the kind of foot will be provided for. In a low, flat foot the entrance to the foot is harder approached than the higher or arched foot. So that in the former case the width of leg is required farther down than in the latter case. The method of

fixing F in Fig. 158 also provides for this. It may be applied in other long work.

Sewrounds.—The cutting of patterns for this mode of making requires also a special attention not so demandable in short work. The fact of a "round" being made inside out, and that after the shoe is sewn, turned, and second-lasted, any inaccuracies in the fit of the top, or in the lasting thereof, is apparent, renders it therefore necessary, if correct work is to be made, that due attention should be paid to the right cutting of the upper pattern. Too much spring is the evil of the generality of the patterns cut by machine-sewn cutters for sewround-makers.

Usual mode of cutting.

A line AB in Fig. 159 is drawn suitable in length for the size about to be cut. It is divided into three parts in points, 1 and 2. At point 2, 2X is drawn at right angles to the line AB. This is made equal to the joint of the last, with an allowance for lasting-over, and if a "shover" is to be used, something also for the space it takes up. X2 is divided into three parts, *a*, *b*, and from *a* a line to A is made. A*a* is divided into four parts, and through 0 a seam-line is made at right angles to A*a*. A suitable curve is made from 0 to 2. After cutting out the shape will appear as W (Fig. 159). This form of pattern is supposed by many to be the best shape for the gripping property so essential to low-cut shoes like these. It is, however, a bad form of pattern. The toe is too springy.

If the opening between the wings were made more like those of an interlocking golosh (see Fig. 124, p. 148), much better results could be obtained in making, and better appearance shoes would result. It is supposed to be a very difficult thing for patent leather shoes to be made by machine without showing (that abomination to the shoe trade) wrinkles. If it is desired to remedy this, the pattern should be *right*. The shape of the average waist of a "round" should be studied, so that proper provision in the

upper pattern may be made for the narrow waist of the sole. If this be not done the quarters are likely to be "pulled" across, to the detriment of the fitting properties of the shoe. The side seams cause a lot of trouble to some

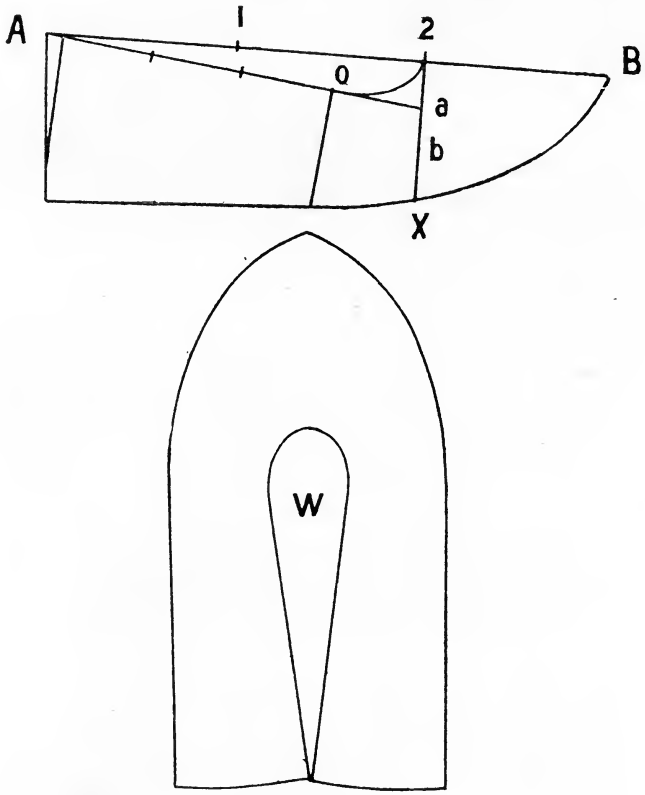

FIG. 159.

folk. If the principle, and reason, of rounding or curving the side seams of *closed* work be understood, it should not present any difficulty. Different materials should be experimented with, and the results watched.

Experiment.

Take a piece of the material to be examined, and lay it on a board, making a straight cut along its length. These two pieces should now be closed and rubbed down. Take them in hand, and vigorously pull it right across the seam (that is, normal to the seam). The edges of the seam will be found to "bag," and to get the seamed edges of piece to resume its former position a piece will need to be removed, making the seam round or oval rather than straight, as originally cut. The amount of removal depends upon the nature of the material and the strain that is to be brought to bear in making. Testing several kinds of leather will soon determine the relative amounts.

Patterns are put in cardboard or metal to use in the workshop. In the former case they may be bound with brass. In the latter they may be in iron, tin, or zinc. Hand shears are used to cut these materials, but often a machine is used to cut the card and metal. The paper patterns should not be pasted on the material to be cut, as that enlarges the paper and distorts its shape. It also prevents the proper comparison after making. The paper patterns should be marked round closely with a fine hard-pointed awl, or a graver may be used. The brass binding machine should be of the Hartford pattern.

Patterns should be legibly marked as to the last, material, fitting, design, etc., and stored in a convenient way to be found easily. All seams should be on the pattern, as it is quite bad enough having the judgment of the closer, without increasing it, with the clicker's want of uniformity.

CHAPTER VI.

CLICKING, OR CUTTING UPPER LEATHERS.

THE cutting of upper leathers is an important branch of the manufacture of boots and shoes. It requires a knowledge of the materials to be cut, and the keen judgment to dispose of the various parts of the skin in the most satisfactory direction. Rigid adherence to the systematic placing of the pattern on the skin cannot be advocated, owing to the character of the material cut into uppers. Skins which come from the same class of animals differ in their quality. The various parts of the skin differ in their relative quality, so that it is impossible to give rigid instructions in the cutting, which would not have to be considerably modified in the practice of actual cutting. Although the want of uniformity in the skins prevents the utilization of defined systems, the study of systems of placing the various patterns, the disposition of the leather in the boot (either to produce a cheap cutting or a good quality line) to produce the best results in manufacture or wear, etc., is not to be despised. The very want of uniformity in the material operated upon demands the systematic training of the mind and the ready manipulation of the patterns upon the skin.

The art of clicking is acquired by a considerable experience, and much valuable time could be saved by a careful preparation outside the board practice. Many failures in the earlier stages of a clicker's career is through the want of not knowing what to do rather than not being able to

do it. The more a cutter gets to know about the after processes of his trade the better for his productions, always assuming that he is able to adapt his knowledge to his work.

Hides (the skins of larger animals, such as oxen, horses, etc.), **Skins** (from calves, goats, sheep, deer, seal, etc.), and **Kips** (the small or yearling cattle) are used for the manufacture of upper leather. They vary considerably in thickness or substance, and quality. In proportion to the improvement in the breed of cattle do the hides become less thick; in the higher breeds they are thin and spready. The difference in substance and quality of the skin from the same class of animals is accounted for by the age, kind of breed, state of health, or the food of the animal from which the hide is taken. Large animals of a class afford skins or hides that are thick and heavy in proportion in the neck. Skins from the younger animals are the finest in the grain, and take the dye better when coloured. The sex of the animal from which the skin is taken affects the quality of the leather produced therefrom, that made from the female being finer in texture and lighter in the necks than those from the male. The mode of preventing putrification of the skin, during its removal from the place of slaughter to the tanyard, affects the quality of the leather when it is made. Some are dried, others are salted, and before the tanning operations can be commenced, the skin has to be restored to its *green* condition.

Anatomical Construction of the Skin.—When the skin leaves the back of the animal it mainly consists of four layers: the hair or wool; the epidermis, or outside skin; the true skin, or corium; and portions of the adipose of the slaughtered. The hair and outside skin and the fatty matter has to be removed before the operation of leather-making proper can be commenced. It is the true skin (cutis, dermis, or corium) that is converted into leather. This is composed of interlacing bundles of white fibres of the sort called "connective tissue." These white fibres are

dense and resisting, and in the middle portion of the skin are closely interwoven, but near the flesh side they gradually become looser and more open, until it becomes exceedingly loose. Some of these very loose fibres are removed during "fleshing." The grain is exceedingly close and compact with these fibres. Here they are separated into their elementary fibrils, and are so interlaced that they can scarcely be recognized.

The true skin also contains a small proportion of fine yellow fibres called "elastic" fibres. They are very stable, and are very little changed in the tanning process. They are found where great elasticity is required for the functions of the animal. The fibres in the skins taken from young animals are more flexible than those found in the skins of older ones.

Modes of Preparation.—The different ways of converting the pelt into leather may be generalized as tanning, tawing, and mineral tanned, or chroming. The former depends upon the astringent property of the bark and other vegetable products, which, when acting upon the pelt, transforms it into leather. Tawing is a preservative method of converting skin into leather. Tawed leather may be reduced to its former elements, whereas tanned leather cannot. Tanned leathers stretch less than tawed. Chromed leathers are produced by a soluble chrome soaked into the skin, which is precipitated by reduction on the fibre. Chrome productions are fast gaining popularity. It is superior in many of its qualities to tanned or tawed leather. It resists water and decay, it retains its strength, pliability, and softness under conditions that would destroy ordinary leather.

Selection of Skins.—The size, shape, quality, and substance of the skin determines its value for a specific purpose. The position or absence of flaws, fleshcuts, and stretchiness also influence the selection. Square skins, *i.e.* when the length is nearly the same as the width, are usually more profitable in cutting than long narrow skins. Long skins

have long necks, narrow prime leather area, thick necks, and heavy bellies. The squarer variety are shorter in the neck, broad in the butt and rib portion, giving a large prime cutting area with a small proportion of offal. Skins unequal in substance are not so valuable as those possessing

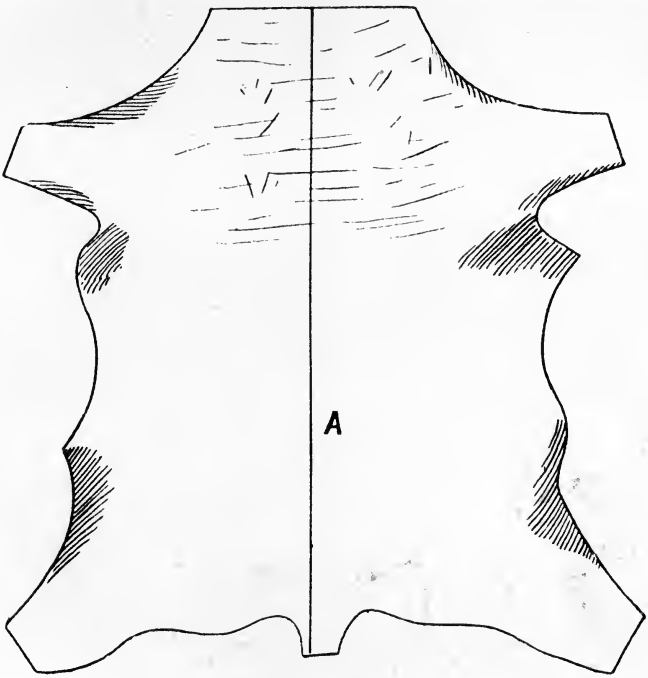

FIG. 160

uniformity of thickness. A well-grown skin is wider in proportion to its length, has a small amount of offal, is free from growth marks, is level in substance over the butt; the shank and offal is light and is well rounded. A skin that is thick in the neck and veiny usually falls away at the shoulder, has thick, awkward offal, and does not present

the same cutting advantages as one level in the neck and shoulder. Fig. 160 shows a diagram of a male skin that has veiny necks, and is coarser in texture than the female skin shown in Fig. 161. This latter diagram also shows the usual division of the skin. The portion A (Fig. 161) is the butt, and is generally the stoutest and best part. It

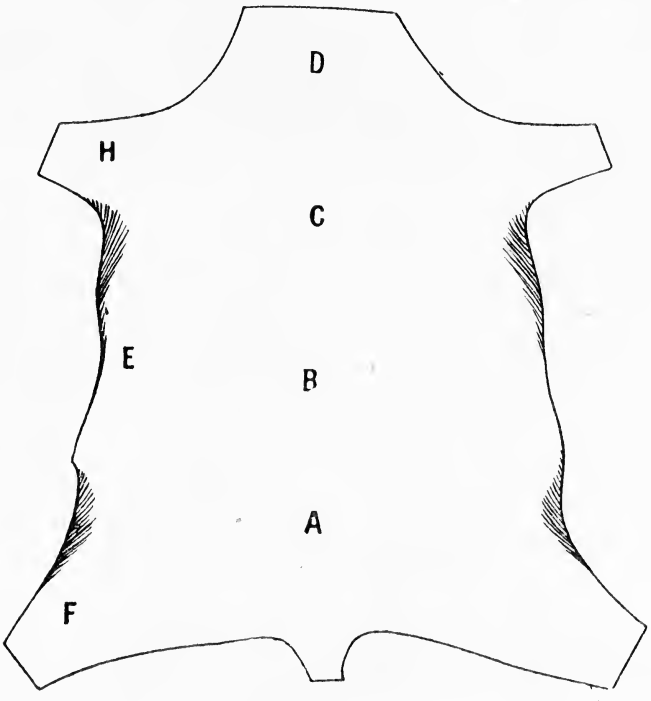

FIG. 161.

is used for the portions of boots and shoes that experience the most strain, such as vamps. B is the ribs, and is in quality the best portion of the skin, being equal to, if not better than, the butt. C is the shoulder, which is fine in texture but lighter than the ribs. It is used for parts of boots that demand light but firm, strong material. D is the

neck which is often veiny and stout, especially in the male skin (see Fig. 160). E is the belly, which is less firm than the shoulder. It is stretchy as a rule. F is the flank, which is soft, loose, and flabby. H is the shank, which is light and fairly firm. The backbone is shown in Fig. 160 by A, which is usually thin and weak, and should be avoided as much as possible, especially in calf-skins.

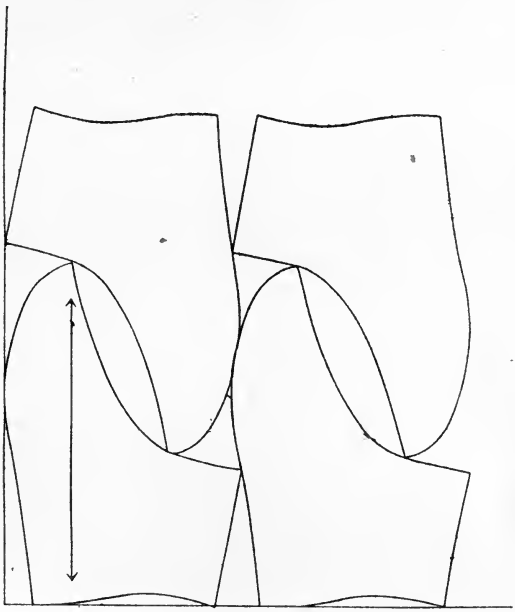

FIG. 162.

Systems.—In cutting up materials for economy, it is a great advantage to adopt some system of placing the patterns. The best system to use depends upon the class of work and the variety of qualities to be produced. The mode of manufacture will also have its influence in the selection of the best system to use for a certain pattern. The cut and height, as well as the shape, of the pattern will determine the best method to be adopted. All these

conditions as well as the nature of the leather must be taken into consideration when adopting a system.

In cutting fabrics into linings, the width of lining and the height of pattern will decide whether the system illustrated in Figs. 162 or 163 is the most advantageous to adopt. If the arrangement of Fig. 162 carries the pattern across the width of the stuff so as to leave no waste at the side on the right hand, then it should be adopted. A waste may be avoided on some widths by resorting to system Fig. 163.

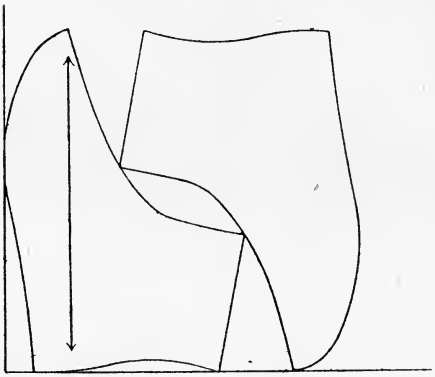

FIG. 163.

The arrow head in this illustration shows the direction of the greatest strength of the lining. The *warp* threads running the length of the material are the strongest, while those threads that go across, the *weft* or *woof*, are relatively not so strong in the ordinary lining. The quality of both threads should be considered when making a selection for a particular purpose. In many workshops vamp linings for shoes are cut so that the toe runs width-ways, the strongest threads being across the vamp. This cutting of the lining is also resorted to in bal and buttoned work by some, to avoid the wrinkly appearance of the lining in the made-up goods. It is used for striped linings when the stripe is required to run the height of the boot. In some cases it certainly does facilitate the clearing of the linings. This is illustrated in Fig. 164. It is also advocated by some to prevent the tearing of the lining when first pulled over the toe during the lasting.

With certain shaped patterns and suitable leather, it is

often advisable to adopt and *adhere* to a uniform system of placing the patterns upon the material, to get the most economical results. Rather than get out of range, the cutter would proceed as though no flaws, etc., were present, utilizing the damaged portion for some smaller pattern, so that the greater waste which would result from the upsetting of the uniformity of the system may be avoided. After a system has been selected that allows the pattern in conjunction with its neighbours to occupy the least surface space, care should be taken to *strictly* keep to the system. Broad, large skins lend themselves to the adoption of systems, the larger the skin and the smaller the pattern in

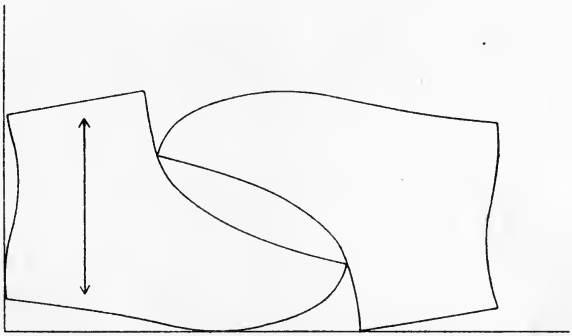

FIG. 164.

proportion, the easier to use the system. Small patterns and large skins are the conditions that most advantageously repay the adoption of a system of placing the patterns. A system may be used that will get the best results as far as the cutting area is concerned, which would not be advisable to adopt if other circumstances were present and were deemed important. The size and substance of the skin, and the levelness of the remaining skins in the parcel, would influence the determination of the best method to adopt in the case under consideration. For the production of large quantities of work, where the skins are fairly level in substance, texture, and stretchiness, a system that

produces work all for one side could be used, whereas with skins that are very irregular and that are very difficult to match up, a system that produces the work to match would be to the greater advantage in the long run, so that for small quantities of work, irregular skins, grained leathers, and many sorts of coloured goods, a system of placing the patterns that lends easily to the matching as the work is proceeded with would be recommended. But for large quantities of a particular pattern with skins of fairly uniform characteristics, the system that calls for the least space may be adopted, even though the work produced is for one side in the first skin, demanding another skin of suitable quality, etc., to be cut up with the pattern reversed. Some portions of men's patterns are better adapted to the utilization of systems than the patterns of women's work. The latter are larger in proportion to the skin than the former. When systematic placing cannot be resorted to, then the edges of patterns having similar curves should be arranged to meet, and the straight-edges placed to corresponding ones in the next pattern. The shape of the same design of pattern, the height, the heel and instep measure, will make a considerable difference in the amount of material used. This may be understood by testing a couple of men's leg patterns upon a sheet of paper, marking the same number of patterns employing different systems, and afterwards carefully measuring and comparing the area occupied. Figs. 165, 166, and 167 illustrate three systems of placing a pattern. They are taken from a standard pattern cut for a person with a flat foot and low-angled heel-measure (refer to p. 42). The leg is also low in height.

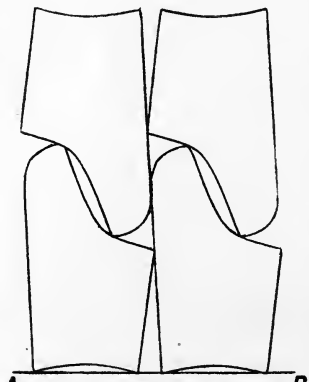

Fig. 165

In system Fig. 165, the back of the pattern is made to fall upon a straight line, AB, and, without reversing the pattern, the toe is made to touch the throat curve of the first row, at the same time also keeping the backs of the second row in a straight line. This, of course, produces the work all one way, needing a second skin to be selected of similar

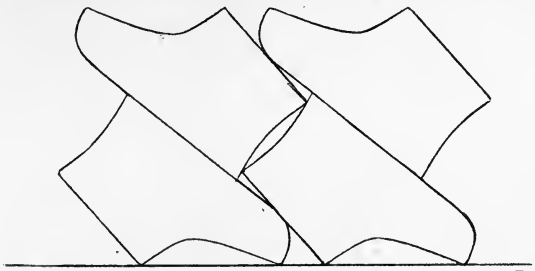

Fig. 166.

quality, and cut with the reversed pattern upon the same system. Fig. 166 shows the same kind of pattern placed so that the top front corner and the toe touches the straight line AB. The work is produced all one way by this method of placing. The other way illustrated is Fig. 167. Work cut upon this plan faces or matches without having to cut into a second skin. By carefully calculating the surface-area of a number of the marked-out pattern, it can be seen which will cut into the least material (see also p. 241).

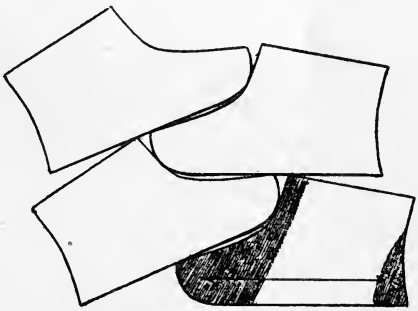
Fig. 167.

If a pattern of a greater heel-angle and a different style of top, as well as being higher in the leg, be used for the self-same systems, it will be demonstrated without doubt

that the shape, size, and height of a pattern will influence the selection of the system that will produce a given number of parts in a minimum of area. Fig. 168 shows

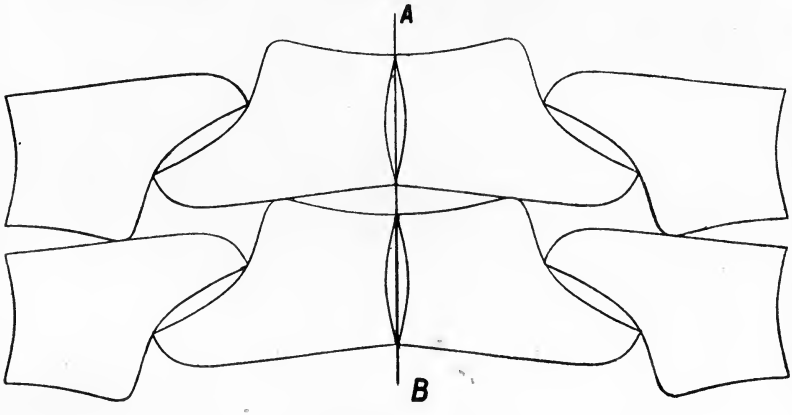

Fig. 168.

the same system as illustrated in Fig. 165, adapted to a skin. The line AB is supposed to be the backbone or centre of the skin. It will be seen, without measurement,

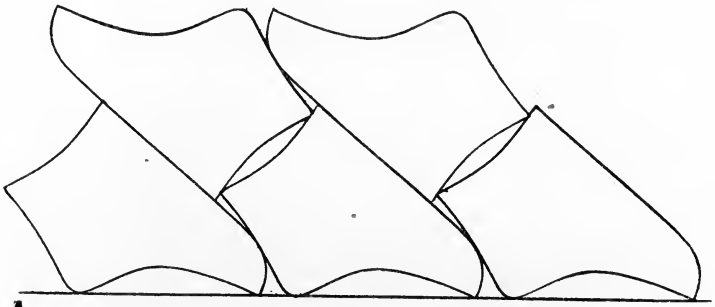

Fig. 169.

to cut into more material than the pattern used for Fig. 165. The work produced on this plan matches the quarters cut on the right-hand side of the line AB. The pattern

used for the next illustration is reduced from a standard cut with a heel-angle line of 42°. The line AB (Fig. 169) is used to keep the front of the top of the leg and the toe in line. It should be carefully studied in conjunction with Fig. 166. Fig. 170 is the same shaped pattern as that shown in Figs. 168 and 169. The work is produced for both sides. The pattern in the illustration is reversed in the right-hand portion for variety.

The interlocking of goloshes will be readily understood by reference to Fig. 124, given on p. 148. Large, level

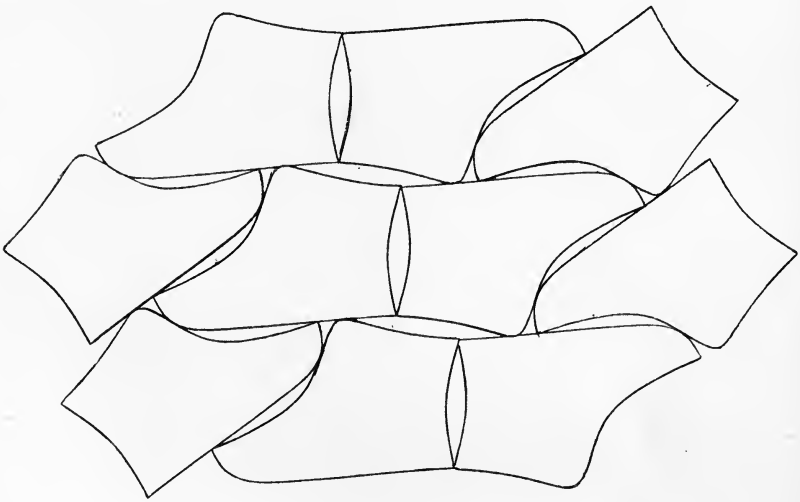

Fig. 170.

skins are those that allow this method of cutting to be adopted with the best results. Very small skins that fall away at the sides are best cut upon the system illustrated by Fig. 125A, p. 149, where the chained outline YX*mn* indicates the pattern required.

Vamps may also be run in upon a system, and is shown by Fig. 171. Here the shape has been sacrificed to produce a perfectly interlocking vamp—a course not advisable. Fig. 123, on p. 147, also shows the same system, which is

generally adapted in long-winged, low vamps. For short vamps that are cut without spring, and where a large surface of material presents itself, they may be made to "run in" on the plan given in Fig. 122A on p. 145.

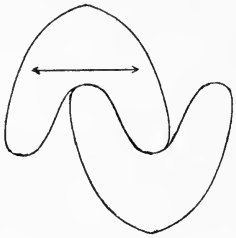

Fig. 171.

Elastic-side fronts and backs may also be worked to a system, and Fig. 172 illustrates a seam-fronted elastic-side pattern, and the mode of placing them to cut into the least possible area. If the front be capped and the material underneath be removed therefrom, a variation of the system will be necessary to get the smallest cutting area. Fig. 173 is

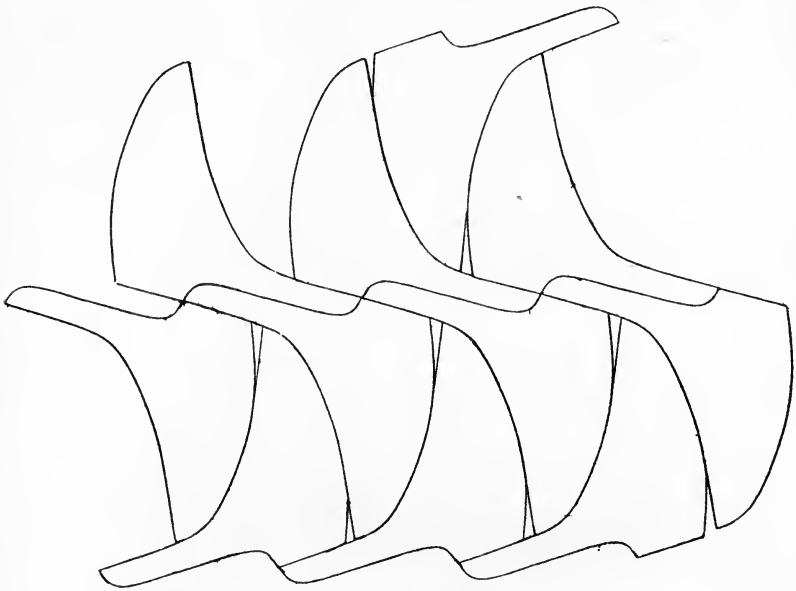

Fig. 172.

the system for a straight-capped front. The system of running the backs is exhibited in Fig. 174.

Systems for placing shoe quarters are given in Figs. 175 and 176. Shoe linings, top-bands, inside and outside straps, counters, tongues, and many other sectional patterns may

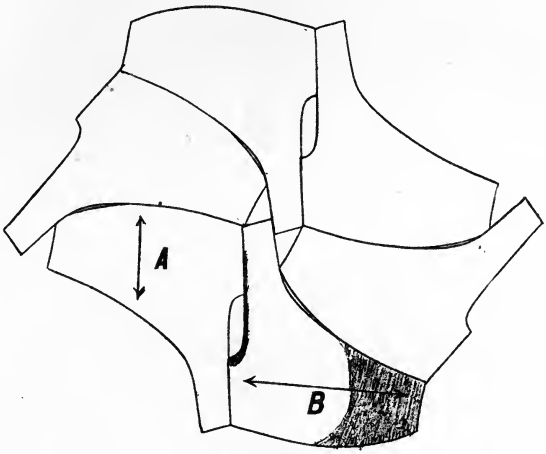

Fig. 173.

also be arranged to be cut upon a system, but the illustrations here given will make the principle quite plain.

Clicking Principles.—Skins should be sorted to size, quality, and substance. The largest and stoutest are usually

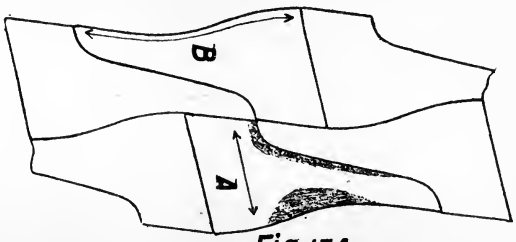

Fig. 174.

reserved for the largest sizes. Some advocate that the largest skins should be cut into the smallest sizes for greater economy, on the lines that the larger the area to

be cut in proportion to the pattern the greater the economy effected. But the substance of the skin would in many cases prevent the adoption of such a plan. If the pattern be large, then a skin that is wide and well-grown should be used for the purpose. The skin should be well examined on the face and flesh before cutting, and the broken grain noticed. The flaws and flesh cuts on the back should be indicated on the face by *marking* with a blunt instrument. They should not be pierced through as some inferior workmen sometimes do. This marking, instead of piercing, will enable the cutter to utilize the portion for inclusion in some part that will not be subjected to much strain and that is free from observation, such as under the button-piece or fly, in the outside quarter of a button boot; or the underlay if the size of the flaw be compatible. The skin may be started either at the left-hand side or from the backbone. The former should be resorted to, when the

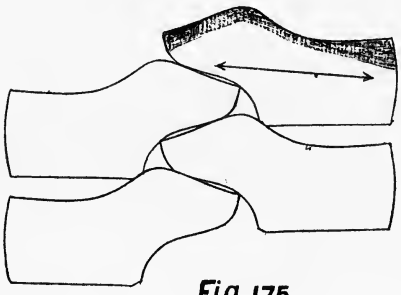

Fig. 175.

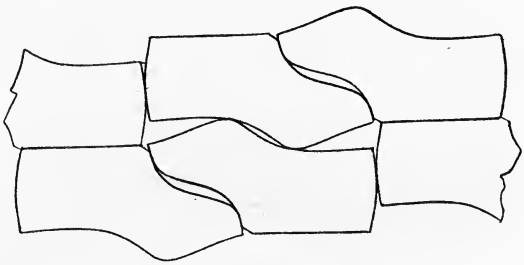

Fig. 176.

quality and substance of the skin at the butt and backbone permit of work being cut without deviating from the

system proposed to be worked. If the skin be weak at the backbone, and not at all clear or suitable for the work to be cut, then it is advisable to start from the backbone. The work should be faced up as a general rule, so that the closer may seam them as the cutter intended them to be in the completed upper, viz. the quarters matching in texture, substance, tightness, and quality. Very light leathers demand that the material should be carefully watched, so that the tightest portions run in a similar way, preventing seams that go awry in the lasted boot. Leathers that are marked with a grain, such as Strasburg moroccos or box-calf, should be matched up as regards the markings or grain. Fine markings should be matched with fine markings and coarse with coarse. The vamps, however, may be matched with a bold grain, while the quarters may be mated with a finer grained material. The portions that are subjected to strain during the manufacture should be cut firm to preserve the marking or impressions. Coloured leathers should be carefully matched, and usually it is advisable to cut complete pairs from the same skin, as the several skins in a parcel are of varying shades.

The cutting may be proceeded with upon one of three lines. After sorting into substances and qualities, the skins may be placed upon the boards, and the whole cut up into the purpose and kind of work it is most suited for. It is without doubt the best method to use for heavy leathers, such as kip and split. To obtain the best results, the patterns should be selected to fit or work closely, keeping in view the adaptability of the parts cut. This mode of procedure is termed the "exhaustive," and is often the one used for women's work.

The skins may be cut upon the plan known as the "selective," and when this mode is determined upon, the skins should be cut as far as possible into the quality desired, and that portion not suitable, left to be disposed of subsequently into other goods of inferior quality, or it may be sold. The selective method is resorted to for the very

best or bespoke work, where the skins are selected of very fine quality, for the production of goods that demand quality as a first consideration.

The third way is a sort of combination of the others, the skins being selected as near as possible of the quality desired for the bulk of the work. These goods are then cut, and to prevent undue waste the portions not immediately adaptable are cut into other patterns for stock.

Stretchiness and Tightness.—When a skin is pulled, the *line* or direction in which it gives or stretches most is technically known as the "line of stretch." This property varies in the several kinds of skins, and also in the same class of skin if tanned or dressed differently. The directions in which the skin yields least when pulled or strained, or are relatively tightest, are termed the "lines of tightness." There is not much variation in the general lay out of the lines of tightness in the skins of various animals, but the substance, quality, and mode of tanning will determine largely the amount of notice that must be taken of the relative stretch and tightness in the skin, and how far these properties will influence the cutting up. When cutting leathers that are very firm, or when cutting the primest portions of the skin, it is not so necessary that such a strict adherence to the lines of tightness be maintained when placing the patterns on the skin. But with stretchy leathers, or when the inferior portions are reached, if a fairly good skin, great care must be taken to so arrange the patterns on the material, that the best results are obtained in the produced goods. It does not necessarily mean any great sacrifice of economy to carry this principle into effect. The great point, even in cheap work, is to pair or mate up the work, paying due regard to the tightness and stretch of the material, so that they stretch on opposite sides of a pair, in a similar way or direction.

The stretch or "lines of stretch" pull across the "lines of tightness," and in a diagram form Fig. 177 will give this

relation,* where the arrow lines indicate the "lines of tightness," and the circular lines cutting them the "lines of stretch."

A good deal of speculation is prevalent as to the cause of the skin being relatively tighter in a given direction, some even affirming that the "lines of tightness" are determined by the direction or lay of the hair. But it seems as though the cause for the relative definite direction of the

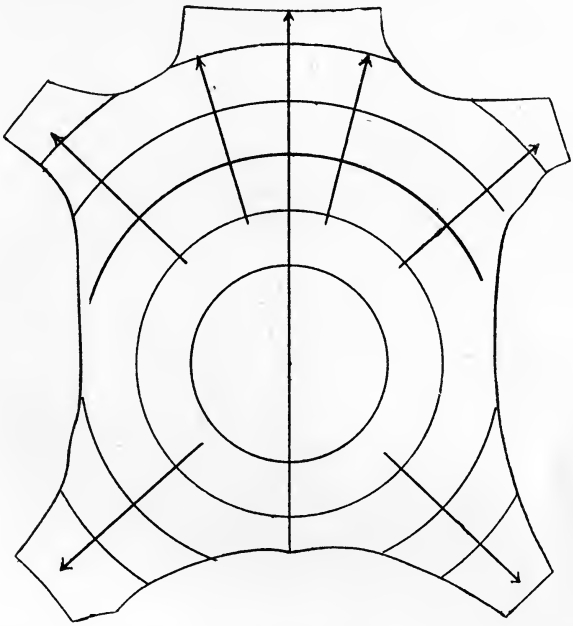

Fig. 177.

tightness of the skin is the same cause for the lay or direction of the hair. Experts do not agree as to the direction of the "lines of tightness," some making them radiate from the backbone line at about an angle of 60 degrees to the flanks, while those to the shank start from the same position

* This diagram is given only to indicate the differences between the "lines," and not to indicate their absolute direction.

as diagramized in Fig. 177, while others prefer to indicate the direction by using a mode similar to Fig. 178. The cause of the relative tightness being ascertained, the direction in which the skin is tight will be the better determined. From the brief remarks given concerning the structure of the skin, and more fully by reference to the chapter dealing with the bottoming leathers, it will be understood which kind of fibre gives the elastic or stretching property. The animal locomotion and movement will determine the proportion and position of these fibres, and by examining a muscular view of the animal after the skin has been removed, the cause of the tightness and stretch is suggested. In Fig. 179 we give a view of an ox with the skin removed.

Fig. 178.

Methods of Disposing. — Having determined the direction of the greatest tightness, the best way to place the material *tight* in boots and shoes should next be considered. Boot and shoe uppers may be cut so that the direction of greatest tightness may be from (*a*) heel to toe, *i.e.* from counter to toe, (*b*) in the line of the seams, or (*c*) tight across from vamp edge to vamp edge. The former is termed "tight to toe," and is the one mostly adopted. The second mode of disposing of the direction of the greatest tightness is termed "tight seam," and is resorted to in a few bespoke houses and with stretchy material when lasted upon a method which demands much "horsing"

or "hoisting" of the uppers. The third method is used with an idea of preventing the upper "treading over" during wear, but is unreliable for work that is to be toe-capped, etc., or where the grain or colour cannot withstand the pulling-over strain. The vamp marked with an arrow in Fig. 171 will demonstrate the cutting of vamps "tight-across;" also A in Fig. 173 illustrates how a front on this principle should be cut. The back marked B in Fig. 174 illustrates the way the seam should pull tight if cut upon the "tight-seam" principle. The usually adopted "tight-to-toe" method is illustrated in Figs. 167, 173 A, 174 B, and 175.

Disposition of Qualities.—The parts of a boot or shoe

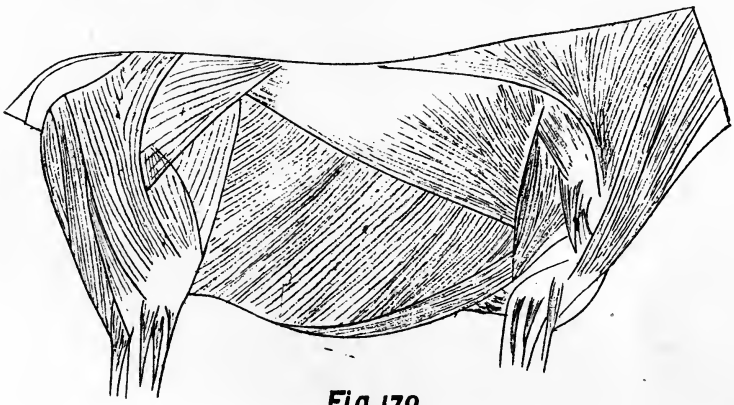

Fig. 179.

subjected to the greatest strain, either in making or wearing, should be appropriated the best portions of the skin, and the better the judgment of the cutter, the nearer to this idea will his work approach. In very cheap work this principle is often violated, a backing up of canvas easing the conscience of the producer on the score of wear and appearance. The parts of a shoe that are strained most during manufacture are, the top edge, the facing, the vamp, especially over the toe, and the back seam. During wear, across the joints, and at the end of the quarters where it

adjoins the vamp, and above the stiffener, are the parts called upon to bear roughest usage. So that the portions of a boot or shoe where the greatest wear or strain devolves, demand the best quality, and the parts where least wear or strain takes place, the lower qualities.

The shading in Fig. 180 shows the portions of a bal or lace vamp and quarter which needs the best material. The same idea is intended in the darkened portion of Figs. 167, 173, 174, 175. The inferior portion may be disposed of in the tops of the legs, and in very cheap work may sometimes be judiciously worked over that portion of the quarter which immediately *covers over* the stiffeners.*

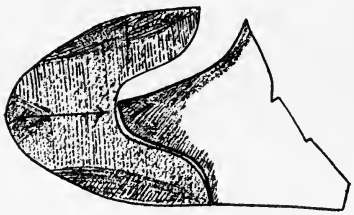

Fig. 180.

This is a very risky business, and only excusable when the best appearance article for the money is desired. Flaws may be placed under the toe-caps or under the overlays, etc., blemishes immediately under the button piece or fly; but inferior leather should not extend in this kind of boot as far as the adjoining of the vamp.

Facings should be cut from the firmest and best portion, utilizing the lighter portion for the topbands.

Button Boots.—The button piece should be thin, pliant, flexible, but tough, to permit of the buttoning and unbuttoning. The flies should be tight in width. For economical reasons, and for the better fitting of the upper, *inside* and *outside* quarters should be used, the smaller quarter for the outside, enabling parts too small for the inside quarter to be used.

Seam-to-toe.—To obtain the best wear, the fronts should be cut tight across, from front seam to feather, and when

* If this be adopted, the clicker should stretch as much as possible the quarter, cutting away the superfluous material, relying on the paste to fasten it to the stiffener.

joined under the gusset the back should be "tight-to-toe" to prevent the back-seam going awry in lasting. Blocked fronts should be tight-to-toe, with the inferior portion towards the top of the leg. This will allow the stretch to be removed during blocking across the front.

Shoe Vamps may be cut tight-to-toe or tight-across, according to the class of trade, method of lasting, and kind of material.

Bespoke Cutting.—For best bespoke, high prices are obtained, and quality is a great consideration. Economic cutting would therefore be a secondary consideration, fitness and suitability for the purpose intended being the primary object to be attained. The parts would be matched from opposite places, either side of the backbone. When bespoke is produced in a factory, or where economy is a consideration, order or stock work would be cut, and the *special* run in.

Calf or Wax Calf Skins are first tanned with bark, afterwards being curried or stuffed with oleaginous substances. These skins excel in strength and flexibility, notwithstanding their comparative thinness. They are curried and blackened on the flesh side of the skin. The French-dressed calf is considered the best, being mellow, more durable, conforming to the last easier, and is of a better appearance than English skins. The English skins are darker on the grain, harsher in hand, and are "kippy" in appearance. They should be well rounded and the offal well got out. There should be a freedom from growth marks and the shoulders free from veins. The neck should be short and level in substance, and the skin feel plump and firm. The shanks, etc., should be short, and free from ragged ends. The edge of the butt should be as straight as possible. The backbone should not fall away suddenly. The skin should feel firm and mellow, and when folded between thumb and finger should not be flabby nor "tinny," and not exude grease. There should be a freedom from flesh cuts that are oftentimes hidden on the black face.

The female skins are considered best for superior work, the texture being finer. In cutting, the hip bone and backbone should be usually avoided, except for inferior purposes. The necks are oftentimes reversed, and make serviceable material when blackened. Several grades of qualities may be produced, and good judgment is needed in the cutting and costing.

Memel calf is dressed on the grain, and is not much used.

Russet calf is imported both for lining and currying purposes. Bordeaux calf is considered the finest sort.

Satin calf is buffed, hence its smooth appearance.

The American calf at first sight appears finer, but it is not a reliable article, either for appearance or wear.

Chrome calf, under various trade names, is largely coming into general use, and is usually a good wearing and good looking article.

In brown calf-skins the so-called growth marks are conspicuous, and care should be taken in placing the patterns so that they may be arranged where the least strain is likely to be experienced, owing to the tendency of their opening and cracking when subjected to strain. The shades of colour should be mated or matched.

Willow calf is boarded and finished on the grain.

Calf Kid is tawed and not tanned. The dried or salted selected calf-skins are softened in water, after which cleaning they are limed until the hair is loose. They are *unhaired* and *fleshed*, and *pured* with dung. Next, they are *scudded* and cleansed in bran drench. The tawing is accomplished in drums, with a mixture of alum and salt. After drying, the skins are moistened and a mixture of oil, flour, and egg-yolks worked into them. In Germany these operations are combined. The skins are drained, and after damping, are staked, *i.e.* drawn over posts, working with a blunt knife. They are again wetted and shaved, and sometimes, to soften them, are dressed with oil, flour, and egg-yolk. They are dyed black, and after *grounding*

are rubbed on the grain with a fatty composition, being finally ironed to give them a fine, smooth surface.

The cutting of calf kid requires good judgment, the work when cut *feeling* different in substance than when in the skin. Firm, large kids are adaptable for systematic cutting, but the lighter, softer kinds have to be carefully watched for the correct disposition of the relative tighter material. The number of qualities producible, and the importance of keeping them well paired up, make this leather a very fluctuating one for commercial purposes. The three kinds usually met with are English, French, and German.

The *English* kid is firm and fine on the grain. It does not readily break up or pipe, if of good dressing. The fibres on the flesh side appear short and closer than the German. They are not so soft or supple as the French, especially near the grain. They take the edge readily from the knife when being skived, and do not therefore make an ideal leather for "turning in" or "beading." The varieties have both white and blue backs.

The *French* kids are of the small kind, and are therefore finer than the English. The fibres are dense and compact. The leather is soft, and suitable for "turning in" or "beaded" work, where suppleness or softness is required. The grain readily breaks up, or pipes, and hence does not make a suitable selection for factory produce, owing to the handling necessary for the processes, and the consequent poor appearance when completed. They are not so nice in appearance for such purposes as those of German or English makes.

The *German* kids are larger skins, and as a consequence are coarser in grain. The fibres are of such a nature that they skive easily, having a flannelly or loose appearance on the back. They are usually white-backed. Some of the makes are equal to the English. The smaller sized skins in some makes are similar to the French skins. The German skins are considered cheap cutting, but owing to the introduction of chrome calf they are not being

dressed in sufficient quantities to supply adequately the demand.

Calf Patent is well stretched before enamelling or japanning, and is japanned on the flesh side. The japanning is done by coating the stretched skins with a paint of linseed, lampblack, and Prussian blue. Several coats are applied, and finally they are varnished. The skins are dried in a stove at a temperature from 160° to 170° F.

Patent should be free from flaws, and have little offal. It should also be firm in texture, not flabby, and the japan should be elastic without any tendency to brittleness.

It should be cut from the brown or grain side, the japan coming next to the board. This will ensure clean-cut edges. Vamps may be "turned in" or folded, if skived on Amazeen, and folded on the Lufkin, having a better appearance than if left raw edge. The toe of the vamp when cut from patent should be solid, but not brittle. Vamps may be cut up to the neck, or across the butt, according to the class of work and quality of patent, when a couple of rows may be taken each side of the backbone. Caps are best cut if worked to a system, a straight line being drawn to regulate same at the butt. If the cap be peaked, the second row may be so cut that the point left in first row may be utilized. Straight caps cut to advantage also when the patterns are systematically placed.

Patent tipping is japanned or enamelled on the grain side, and varies considerably in quality. It is made from split hides.

Horse Hides are dressed as *cordovan*, a leather that is durable, fine in texture, and susceptible of taking a high polish. It should not be lasted so tightly as calf. *Crup butts, cordovan-cross-pieces*, etc., are made from portions of horse hides. Crup, when properly tanned, is waterproof, and easy to wear; but if badly tanned, burns and blisters the feet of the wearer. Horse hides are split, and enamelled, and marketed as *enamelled horse*. The bellies are stuffed

and sold as grain or smooth. Horse hide is also used for "flat calf" and horse kid.

Goat Skins vary considerably in size, thickness, and quality. They are finer in texture, and tougher than sheep skins. They are variously dressed. Moroccos—oily and shumac tanned—are made from goats. Persian goats, memel goat, levant goat, and Strasbourg, are varieties of leather made from goat skin.

They are chromed as glacé chromes, and if carefully selected are a very durable leather. An outline of the chroming by the two-bath process is as follows :—

> The skins having been brought into a suitable condition for tanning, are first treated in a solution of bichromate of potash, to which has been added sufficient acid to liberate a part of the chromic acid. In this solution they remain until the fibre is thoroughly struck through. They are then drained, or pressed, and passed into a second bath consisting of thio-sulphate of soda, to which acid is added to liberate sulphurous acid. In this manner the chromic acid and bichromate in the fibres are reduced to a green chromium salt, which fixes itself in the fibres, rendering it quite insoluble, even in boiling water—in fact, converting it into a perfect kind of leather.

Sheep Skins when tanned with bark are known as "bazils." Sometimes they are split, the upper, or grain, side being tanned with sumach, and called "skivers." Roans are made from sheep skins. Imitation moroccos are made by tanning with sumach. The value of a sheep skin for leather purposes is in inverse proportion to its value for wool. Sheep skins are tawed, and known as alum mock kids. When tanned and stuffed, they are called mock kids. *Persian* sheep skins are considered the best. Sheep skins have not much wearing capacity, and are not favoured for the covers or outsides of boots or shoes.

Glove Kid.—For glove kids the skin of the lamb is chiefly used. The best are of French production. They

are tawed, which is done as follows: The skins are soaked, then limed, and unhaired by a blunt knife on the beam. After fleshing they are "bated," and then fleshed a second time. The skins are then thoroughly cleansed and drenched with a bran drench. They are now subjected to a mixture of alum, salt, flour, and egg yolk, and when *tawed* are dried and dyed. Glove kid is a very soft, pliable, stretchy leather, and not suitable for work liable to be exposed to a wet climate. The cutting, owing to the smallness of skins in relation to the pattern, and the necessity of cutting all one way of the stretch, and matching the work produced, is only entrusted to men of competent judgment.

Russia.—Real Russia leather is very strong, pliant, and durable, and is distinguished by its peculiar odour. It is tanned with bark from the willow, poplar, or larch, and the scent is given with birch-bark oil. Many imitations are produced, some of them only having the scented odour for the characteristics of this expensive leather.

Russia Hide is tanned leather, and is usually fine in the grain. It has no grease used in its manufacture, and is not adapted for a hot-footed wearer. The want of evenness in colour makes it somewhat difficult to cut, and great care should be taken to match up *during* the cutting.

Shoe Butts, sometimes termed "slitters," are used for heavy work. They are tanned and curried, and are oftentimes heavily weighted. Some are memeled on the grain, and sold as memel shoe butts.

Satin Hide is the grain split of a large hide, and is tanned with hemlock. The grain is buffed, and gives that smooth appearance so noticeable. Owing to the largeness of the side, it is considered an easy leather to cut up. The backbone is to be avoided for vamps, and the systematic placing of the pattern can be carried out in this leather, if clean on the face, to its fullest extent.

Grain, Glove Hide, etc., are the grain splits of similar hides to those used for satin, but the grain has not been

buffed, and the different mode of dressing imparts a softer feeling to the leather. The scars, or growth marks, as they are sometimes supposed to be, should be avoided where any strain is likely to come.

Splits are the flesh splits of hides used for satin, grain, or glove. Cheap work is produced from this leather. Second-flesh splits are sometimes taken, and are known as "fleshes," or "slabs."

These latter hemlock-tanned leathers are not so tough in fibre as calf, etc., tanned with other barks. This is owing to the strength of the hemlock, which quickly tans through. To prevent some of the harshness, the liquors are made weak for upper leathers, and a slower process adopted when tanning.

Glacé Kids are produced from skins similar to those used for glove kid, and are tawed pretty much on the same lines. When selecting them for boots and shoes, an absence of "veins" should be considered a good feature. The skin should also be mellow, but not flabby. Harsh skins should not be confounded with firm skins. They should be evenly dyed. The same remarks, emphasized, made about glove kid, here apply.

Kip * was formerly the term used to describe the skins of young animals, or yearlings, but is now chiefly used to denote the size of skin. They are tanned, or curried, either whole or in sides. They are usually cut right up.

Porpoise makes a soft, strong, durable leather, used for men's work and laces. White whale is often substituted for porpoise.

Kangaroo skins may be either tanned, tawed, or chromed. When tanned, mimosa is the agent largely used. It is an excellent leather for quality, being strong, elastic, and thin.

Alligators.—The skins of the young ones are often used for boots and shoes; but, owing to the fact that the bellies

* This term is also used to denote a thirty-skin parcel of such as skivers, chamois, etc.

and flanks only are suitable for this purpose, it makes a very dear cutting leather.

Sorting Qualities.—The cut work may be sorted afterwards, by separate men, into qualities, instead of the cutter being responsible for the selection.

It is sometimes advisable in very large establishments, where a strict adherence to uniformity of quality is essential, for one or so to be responsible for qualities; but it is often open to abuse, owing to the cutter relying upon the sorter to make right errors of judgment in placing the patterns in awkward positions. To obtain the greatest economy in cutting, several-sized or variously shaped patterns should be provided, so that the portions of the material, when cutting, not large enough for the pattern, may be utilized for a smaller-sized one, or one of different shape. The weight of the cut stuff is also sometimes considered in making a decision for the several qualities.

Machinery.—For certain portions of the work, dies or knives may be used to advantage. Topbands, facings, inside and outside straps, tongues, etc., may be thus cut under a press. By giving a little consideration in designing the patterns, many of these named parts may be made to serve for several sets of patterns. Offal may be cut by handled dies and mallet even in smaller factories that would not have suitable work for a press.

A clicking press of the Revolution type is illustrated in Fig. 181. The beam, or head, rises at the completion of each revolution, and, when the operator presses his foot on the treadle, it descends and dies out, returning and stopping at the highest point, until released by a second step on the treadle.

Machines for measuring the surface-area of the skins are also used with advantage. There are two kinds usually found in use, the "Sawyer," and the "Justice." The former machine has mechanical means provided for collecting the various measurements observed, when the skin to be measured is placed between the roller or feed

and the upper wheel. The "Justice" machine consists of a roller or shaft, so arranged that the leather put on the front board feeds on its highest point. Separated by a slight distance above this shaft, is arranged, some two inches from each other, a number of wheels mounted on levers, pivoted at the back, so that when anything is placed

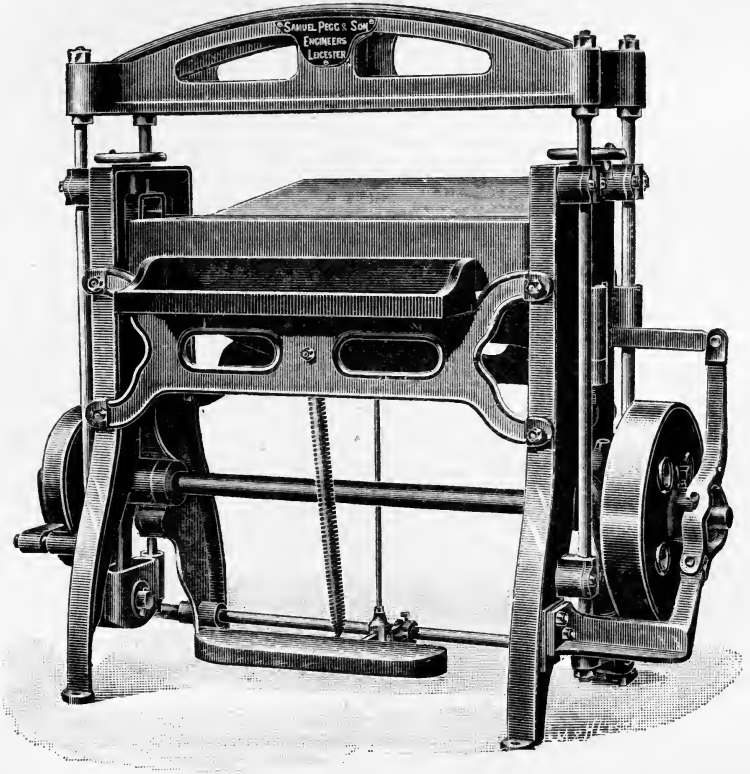

FIG. 181.

between the roller and upper wheel, this pivoted lever allows the wheel to rise, and automatically adjust itself to the substance of the material used. On the face of each of the wheels an involuted slot is made, into which works a finger, preventing the wheel from slipping without registering.

Attached to the spindle of each wheel is a cord, which is coiled round the drum as the rim of the wheel passes over the material. The cord passes over a pulley at the back of the machine, and is fastened at the other end to a hollow metal cylinder, which works in a tube. Each of the tubes is connected at the bottom with a main vertical tube, in which is placed a float. The float carries a lath, marked in equal units to represent square feet. Before using, the main tube and its tributaries are filled with water. When the cord is coiled round the spindle of the wheel, the tube attached rises, and the water in proportion lowering on the main tube, and, according to the amount lowered, so the scale is effected.

The accuracy of the machine is proved by using pieces of cardboard (cut to a square foot, half square foot, etc.), to mark up a skin, totalling the sections, and thus obtaining the number of feet portioned off. This skin placed through the machine, and the area indicated, coincides with that obtained when using the cardboard patterns.

The *skiving, scarfing,* or *bevelling* of the various parts by machine, is often done in this department, so that any damage may be easily replaced, etc. The Douglas skiver (a fixed knife machine) is used for the heavy leathers, and the Amazeen (a revolving knife—see Fig. 187, and p. 247) for the lighter leathers.

Machines for scolloping the edges of vamps, caps, top-linings, etc., are also used, and an illustration of Squire's machine is given in Fig. 182, which is one of the best for this purpose. Toe-cap perforating machines are also used in this department.

Costing.—Calculating the cost of the various sections and qualities of the cut work requires a considerable experience and judgment. The mode often adopted of *marking* up a selected skin into the kind of pattern to be costed is not to be recommended. The cutting up of the skin, or a number of them, is very little better, when they are selected from a parcel, so as to be the most suitable to produce the

work under consideration, and afterwards the work is to be cut from skins not so favourably selected. It is impor-

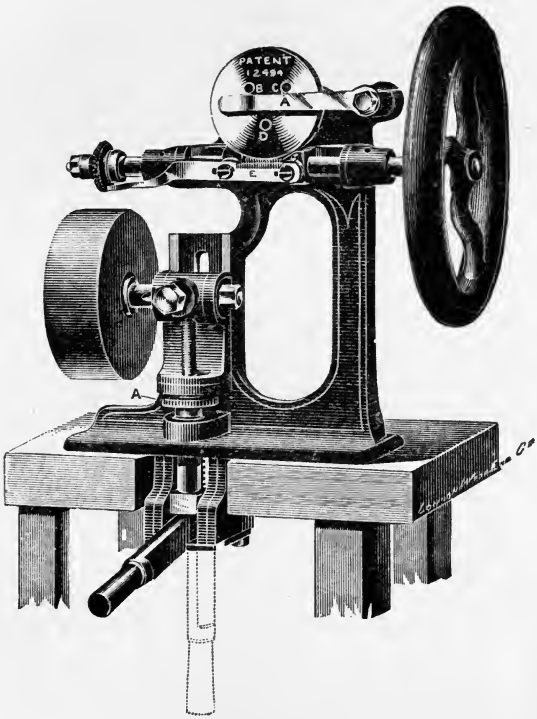

FIG. 182.

tant that the same conditions should be observed, when ascertaining the cost, as those under which the bulk of the work is to be cut.

> For instance, suppose it is desired to obtain the cost of the various qualities a certain brand of calf kid will produce. Further, suppose a dozen of them to be given out to the cutter to cut right up into "what they are fit for." The relative cost is then apportioned to the results, and the prices determined used as a basis for testing the product of the bulk of the trade. If the bulk of the kids are not cut upon the same plan, viz. the *Exhaustive*, but

are cut into orders that have not been selected to properly exhaust the skins into the qualities, etc., they will produce, then, the conditions being different from that ruling when estimating the sample parcel, the cost will not be uniformly realized. This is the more apparent when the cutter has "worked" or "run in" patterns in the test case to obtain economical cutting, but has been restricted in the bulk lot from following the same plan.

If lots of leather submitted by the leather merchant as samples are to be used for costing purposes, care should be taken to allow for enhanced selections, and a careful record of size, weight, etc., should be taken to prevent inaccuracies when cutting up bulk lots.

The way the leather is bought should be considered in costing. Leather is purchased by hand—so much per dozen or skin; by weight; or by surface—so much per square foot. When purchased by weight, the manner in which the weight is produced should be noted. Leather heavily weighted with fatty substances or glucose is unprofitable, and tricky to cost. When cutting leather purchased by weight, it should be borne in mind that the lighter the material the cheaper the cutting, and a slight increase in substance of the bulk is sufficient to add to the cost of the cut stuff. When buying by hand, careful records should be taken of the surface-area and weight of each skin, as well as the average of each parcel, so that there may be no dispute with the bulk, or any other brand which may be supposed to look cheaper. Skins should be tested, when purchased by measurement, and the method tried by some of measuring the length and breadth of the skin, and then multiplying them to get the square measure of skin, should not be relied upon. Every portion of the skin is measured and included in the total, and should be verified accordingly.

Material and labour are sometimes costed together, a usage that has certain advantages, among which may be mentioned that with imperfect skins the cost of cutting material and labour is properly estimated, and any extra

attention given by the cutter to his material is credited readily to his account.

The simplest materials to cost are those that produce work of a limited number of qualities, the difficulty of allotting relative prices to the several qualities being many. Fabrics, whether for outsides or linings, can be easily costed. The cost per yard, and the number of pairs that may be cut in a given area, being known, by dividing the price by the number of pairs an amount may be obtained which will give the "cost" of that particular part. The *quality* of the fabric is equal all over the same piece, and it is only a question of the *area* taken by the pattern, and the way the area is distributed as regards shape, that affects the cost.

Many of the leathers used for "fittings" are costed just as easily. It is only when the question appears of *selecting* (either as "best," "seconds," or "thirds," or into prime and inferior) the cut stuff into qualities, that difficulty is experienced.

> For instance, supposing a roan cut into socks, by dividing the price of the skin by the number of socks cut the cost is determined. There may be, *strictly* speaking, a difference in quality between some of the socks, but they are not, in this case, *sorted*, so they are priced as though no difference existed. Compare this with a case of Persians cut into topbands or toplinings, and facings. The facings, by their office, demand the better material, and the introduction of this *selection* alters the mode of costing. The topbands are not so valuable as the facings, and if topbands only were required, leather inferior in quality and cheaper in price could be used, so that in pricing the cost of facings and topbands, the topbands would be priced on such a basis that they could be produced in quantity *without* the facings. Area only is not what determines here the cost—the facings are enhanced in value over the area cost, for selection or quality purposes.

The cost of the various qualities of a given design may be determined by cutting up the skins considered suitable

into that design, only "working in" other designs *where absolutely necessary* in order to save palpable waste. After the work is cut, it is carefully sorted into qualities. The various qualities should then be costed at such a price that they could be cut in quantity, if demanded, without loss. This often is done by assuming that the several qualities are produced from other skins, which yield that quality without producing large lines of stock.

Suppose a skin cost 12*s.*, and when cut up yielded five pairs of ladies' lace boots, and one pair of shoes. Sorted in qualities, there were, say, one pair best, two pairs seconds, and two pairs thirds. The shoes were seconds. To price, start at the lowest quality of the easiest and cheapest produced in quantity. The shoes, *cut out of other skins*, or roundings, could be produced for, say, 1*s.* per pair. The total of this would be—

1 pair of shoes at 1*s.* ... 1*s.* 0*d.*

This, taken from the original cost, would leave 11*s.* to be divided *pro rata* among the five pairs. The cost of the two pairs of thirds is ascertained on a basis of its being produced in quantity without loss from other sources. This would probably be 1*s.* 9*d.* Total, 3*s.* 6*d.*

The *average* cost of five pairs is 2*s.* 3*d.*, and may be used to price the seconds. The cost so far being, say—

	s.	*d.*
1 pair shoes at 1*s.*	1	0
2 pairs 3rd lace at 1*s.* 9*d.*	3	6
2 pairs 2nd lace at 2*s.* 3*d.*	4	6
then 1 pair 1st lace at 3*s.*	3	0
	12	0

The principle this is intended to illustrate is, that all parts or portions are priced on such a basis that, if called upon to produce them in a given quantity, it may be done without loss, or producing other parts that are useless for utility purposes.

Estimating the cost is often done on a plan not to be commended, viz. that of first obtaining the average cost per

pair, and adding or deducting a fixed amount from this for qualities above or below. This is not reliable, owing to the varying proportions that are usually produced—in fact, it would only apply where the number of pairs in each quality were equal, and either could be produced in quantity if desired at the price. Comparative prices are also placed by some upon the various qualities, beginning with the commonest, putting thereon such a value that they may be cleared off hand. This practice, however, is not applicable to modern concerns, owing to the great uncertainty existing in supply and demand. It has been suggested that when three qualities are produced, that after the average price has been obtained, the thirds should be priced at a cost per pair that they may be produced in quantity out of any other skin, and the difference between this and the average will fix the amount to be added to the average to obtain the cost per pair of the best. Such methods only hold good when equal qualities are produced. When offal is cut into fittings, the cut stuff must be priced at an equivalent price, that would be obtained by cutting these parts from other material. It is advisable, when cutting work from the heavier leathers, to *weigh* the product, and thus obtain the cost of cut stuff per lb. It will be found afterwards useful in estimating the cost of varying designs.

The "cost" of cut stuff may also be ascertained on a weight basis. This method is more largely used for kip, split, grain, calf, and the larger and stouter calf-kids. The offal and scraps are first weighed, the former being priced per lb. to allow for its awkwardness, heaviness, and loss in cutting therefrom, when compared with other material that may be substituted for it, or made to serve the same purpose. The remaining amount left after this has been deducted is to be divided *pro rata* for the primer cut stuff. Sometimes, however, the cost per lb. of cut stuff for the several qualities is arranged by adding to the original cost per lb. a *per centage* to obtain the cost of each quality, as per sample.

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Taking the price given per lb. as a basis, then—
to obtain the best add 50 per cent.
„ „ seconds add $33\frac{1}{3}$ per cent.
„ „ thirds „ 25 „ „
„ „ fourths „ $12\frac{1}{2}$ „ „
the fifths being priced same as original.

A test of cutting, often resorted to, is to determine the proportion of the waste or cuttings to the whole, and this rate would vary from 1 in 5 to 1 in 8. About 20 per cent. is considered fair cutting. It should be noted that nothing should be deducted from the pricing to allow for slow-selling stuff, etc. If it be considered necessary to make an abatement for such purposes, the proper time to do so is when the profit per centage is added.

Where facilities are provided for measuring leather, or where skins are purchased by measurement, the costing and verifying of same may be done on a measurement basis. Some have advocated the measuring of the surface-area of the pattern. The shape of the pattern, giving a certain area, influences the amount of *cutting* surface more than the absolute area itself, so that the surface-area is only useful for cutting purposes, to compare the *minimum* area in contrast with the area obtained on a cutting basis.

To illustrate this, refer to Fig. 165, which shows a straight-top goloshed leg, and the area of a pair of such would be 90 sq. in. The *cutting*-area, by such a system as Fig. 167, per pair would be 92 sq. in. Again, the goloshed leg shaped as Fig. 168 gives an area per pair of 107 sq. in., and cut on a system as Fig. 168, the *cutting*-area would be 128 sq. in.

To obtain the surface-area of a pattern, first divide it into a number of easily calculated plane figures. Usually triangles are the best to adopt. Fig. 183 shows a man's goloshed leg and woman's shoe so treated. The area of each triangle is now calculated, which may be done by any recognized rules. The total of the areas of all the triangles gives the area of the pattern.

Example.—To calculate area of triangle *a*, *b*, *c*, Fig. 183. Measure in inches * the length of the base, *a*, *b*. In this case it is 7·1 in. Then take the *perpendicular height*, *c*, *d*. In this case it is 2·8 in. The rule † is to multiply the base by *half* the *perpendicular height*, and the product gives the area.

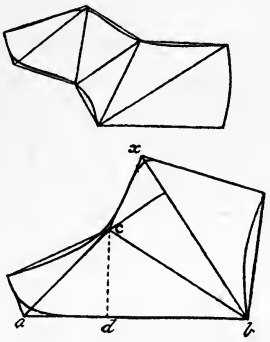

FIG. 183.

The cutting-area of a given pattern for a certain system may be obtained by marking out the pattern a number of times, and measuring the area ‡ thus enclosed.

The following example will illustrate the difference between the *surface*-area and the *cutting*-area of patterns :—

Surface-area of pattern as Fig.	165 =	90	sq.	in.
Cutting „ „ „	167 =	92	„	„
Surface „ „ „	168 =	107	„	„
Cutting „ „				
(*a*) cut to system, „	169 =	115	„	„
(*b*) „ „ „	170 =	128	„	„
Surface-area of pattern as „	175 =	71	„	„
Cutting „ „				
(*a*) cut to system, „	176 =	81	„	„
(*b*) „ „ „	175 =	84	„	„

By keeping careful records of the cutting results of a particular shaped pattern, an estimate of the *cutting*-area may be obtained, and this used to give the comparative

* It is recommended for convenience and accuracy that a decimal scale be used.

† Or half the base multiplied by the perpendicular height may be used.

‡ To get the area of the shapes thus enclosed, the following rules will be useful :—

The area of a rectangle, square, rhombus, or rhomboid, is found by obtaining the product of the length by the perpendicular height. The area of a circle equals half the product of the circumference by the radius, or the square of the radius multiplied by 3·14159.

basis for costing, the value for qualities being arranged on a similar plan to that previously described.

The cost of the various sizes in a range may be easily ascertained, providing the standard or sample size be known.

A number of parts may be cut in cardboard of even texture and weighed, and the results compared with an equal number of parts cut in card from the sample pattern. It is useful to have a table prepared on such a plan to be acquainted with the extra cost entailed in cutting, say, 5 to 7 over 2 to 4's women's.

CHAPTER VII.

UPPER FITTING AND MACHINING OR CLOSING.

THE putting together of the various parts while stitching is termed "fitting." These parts are, where possible, fitted as intended and designed by the pattern-cutter.

The correct fitting together of the various parts of the upper is an important branch of the manufacture of boots and shoes. It may be performed either by tacking with a needle and thread, or by fitting together by means of an adhesive. Some portions of the work are put together directly under the machine, without the use of either methods just alluded to. There are certain preparatory processes to the actual fitting proper, and a large degree of the excellency or otherwise of the fitting depends upon these initiatory processes. The object to be aimed at should be, to unite the parts with such suitable seams that the flexibility of the leather be maintained. To this end, the pieces that overlap should be made to have the effect of one substance. The rigidity of the seam should not be increased with stiff and non-yielding adherents.

The patterns are cut either to fit, part to part on the cutting-board, or allowances have been made by the pattern-maker for the alteration in size and shape consequent upon the alteration of the plane of the material when cutting to the pattern to that occupied when fitting, and the displacement due to substance. The *modus operandi* of fitting adopted in any particular case will depend, then, which view has been adopted in preparing the pattern.

To clearly understand this difference the student is recommended to try the following experiment:—

Experiment.—Take a pattern about 1½ in. by 6 in., and use this to cut some pieces of linen lining, glacé Persian, calf-kid, roan, kip, calf, etc. A piece of the cut-out linen should be laid exactly over a piece cut from calf, and the two short sides seamed together, as *ab*, *a'b'*, in Fig. 184. After seaming they should be bent round as CD, and the displacement of the lining noted. Repeat with the other substances and compare results. It will be seen that to get the lining to fit the stouter outside piece, it would be necessary to make it smaller. This

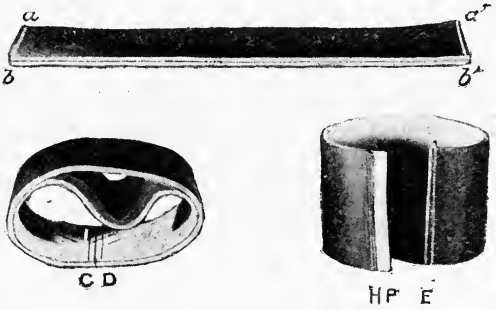

Fig. 184.

has been illustrated by Fig. 184, EH, where the part, P, beyond H, shows the amount necessary to be removed to make the lining fit closely to the stouter piece. The experiment will also show how the amount varies with the substance of the two materials used.

The first process in actual work, after counting the parts, etc., is to lay them out and ascertain the way they are cut. If on the flat-paper-pattern method, allowances will have to be made during fitting for the substance of material used. If, however, this has been correctly estimated and allowed for in the pattern, the process of fitting is simplified and cheapened.

Skiving.—When two pieces of leather have to be

overlapped they must be suitably skived. The *skive,** *scarf,*† or *bevel* varies with the conditions of each case. The idea is that the two substances, when joined, shall present the appearance of one. In practice this would be modified according to the strength of the materials skived. *Generally,* if the two substances to be united are equal in substance, the reduction by bevelling should be done on both. If a lighter material is to be affixed to a stouter, then the reduction would mostly be from the stouter. When skiving such portions as goloshes, care should be taken that no lumpiness is apparent on the inside of the upper. This will make it necessary to bring the portion underneath—we are here referring to a lap-joint—to a "feather" edge, while the edge of the overlapping portion must retain a sufficient substance to make a solid seam. The width of skive for seams should be nicely adjusted, so as to avoid any undue weakening of the seam. Where the vamps or quarters, etc., are not matched as to substance, it will be necessary to reduce the portions thicker than the others to a uniform edge.‡ The kind of skive made will be determined by its purpose. If it be only required to reduce the substance so that the overlapping portion may not be clumsy, and yet not weaken the substance materially for strength, then a bevel must be used that will be as illustrated by Fig. 185, where AB is removed leaving a proper bevel, without detriment to its supporting properties. The *incorrect* skive for the purpose of overlapping, seams, etc., is illustrated by CD in the same figure.

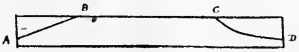

Fig. 185.

For "turning-in" § work a different sort of skive or

* Supposed to be derived from *shive,* a slice.

† Derived from a timber-joint.

‡ An upper-leather splitting machine is often used to make the various portions of the upper of uniform substance, but the reduction here refers to the edges.

§ Some localities confuse this term with "beaded." The correct usage of the term *beaded* is reserved for the inserted "bead."

scarf is desirable. The portion that is turned in should be of such a substance that when in position the main portion of the turned-in part should be together equal to the original substance of the material. This may be accomplished in two ways. The skive may be *gradually* brought to a "feather edge" in such a manner that when turned in it may, together with the leather of the body, be of the substance of the original. This kind of "turning-in" skive is illustrated by A and *a* in Fig. 186. It is the form of skive most adapted for hand turning-in. The other way of skiving for turning-in is shown by B and *b* in Fig. 186. It is the sort of skive most adaptable to "*turning-in*" or "folding" machines. The substance of the edge is not reduced to a feathered edge, which would cause a tendency to curl when being put to the gauge of the folding machine.

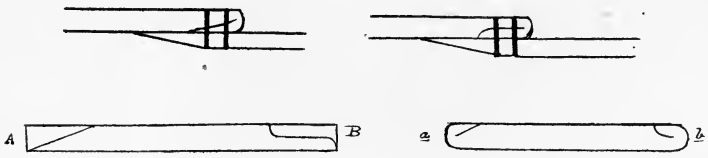

Fig. 186.

The skiving by the hand-process may be performed, either by pushing the knife *away* from the body of the user, or by drawing the knife during usage *towards* the person who skives. The former is used for turning-in, while the latter is more adaptable for materials of the nature of calf or kip. The skiving may be done by taking long, clean sweeps with the knife, or by short strokes or bites. The condition of the cutting edge of the knife and the texture of the material will determine which practice is to be followed. Generally, as long a sweep as possible should be taken. At any rate, the skive must leave the work uniform throughout its entire length. The skive for folded-in work should be twice as wide as the fold to be taken.

Skiving Machines are constructed on two principles. Those of the "Douglas" type are made with a fixed or stationary knife, against which the leather to be skived is delivered by means of the rollers. This class of machine is most effective on firm leathers, such as calf, split, kip, etc., but by careful operation certain dressings of calf-kid may be skived on this type of machine.

The Carver skiver is a useful machine for medium and heavy leathers.

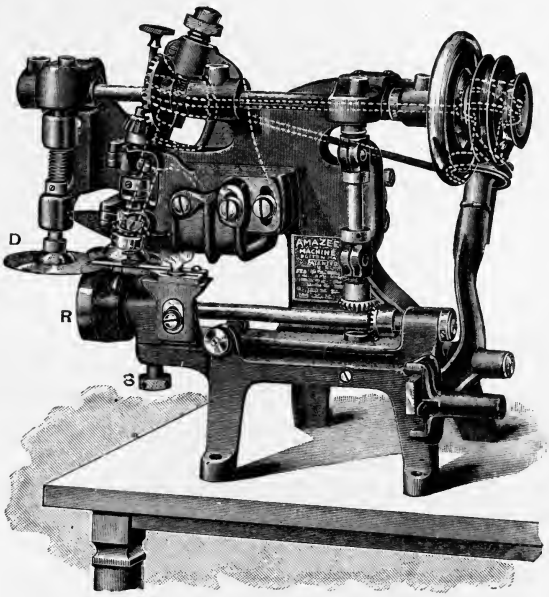

Fig. 187.

For light, flexible, stretchy leathers machines with revolving knives are most effective. The best of this type is undoubtedly the "Amazeen." The old pattern is without knife-grinding attachment. The new model has, besides other improvements, a knife-sharpening apparatus. Fig. 187 shows this pattern machine. The new high-speed machine has an enlarged bevel gear, increasing the speed of the knife without making the guiding of the work

impracticable. The cogs are also splendidly protected, minimizing accident to the operator. The added knife-adjusting screw and other improvements make the machine more easy of manipulation and adjustment.

Description of "Amazeen" Machine.—The new high-speed "Amazeen" leather-skiving machine is driven from a transmitter. The balance-wheel makes from 1200 to 1400 revolutions per minute. It will be seen by Fig. 187 that the main shaft of the machine imparts motion, on the left hand, by means of worm and gear, to the feed-disc D. To the right another worm and gear gives motion to a vertical shaft, that at its lower extremity revolves the roll-feed shaft R. The knife is driven by a bevel gear that works a raw-hide bevel gear on the knife-shaft. The knife-bracket is adjustable to any desired bevel of skive by loosening the thumb-screw and central screw, and the knife-bracket-adjusting screw will enable the knife to be given the desired angle to the feed-roll. The bevel gear on the main shaft should be loosened before any adjustment is made with the knife-adjusting screw. It is well to also raise the knife by means of the knife-screw before altering the bevel of scarf. This will prevent the knife coming in contact with the feed-roll, should the knife be adjusted for a flatter skive.

To place the guide in position, the set-screw S should be released, and the screw in front of the feed-roll shaft should be turned so as to bring the shaft towards the operator. The back edge of the guide should be adjusted to come over the top or highest part of the feed-roll, so that the material may be presented directly to the edge of the knife. The shaft is returned so that the back edge of the guide is as close as possible to the knife edge without contact.

The knife must be kept keenly sharp to produce uniform skiving.

The "Amazeen" will produce excellent work, especially for turning-in, if carefully studied by the operator.

Machines are also used for reducing or skiving the toe

portion of vamps. The "Gott" machine is largely used for this purpose. Another machine skives the vamp-toe, and at the same operation marks the position of the toe-cap with the figure denoting the size.

After skiving, if for turned-in work, it will be necessary to notch or nick the edges of the inside curves. This is to allow the folded portion to lay flat to the leather, and care should be taken that the nicks or serrations do not reach to the visible edge of the fold.

Ink.—The edges of vamps, goloshes, quarters, etc., if not turned in, should be coloured the same as the face of the leather. If black, the ink should be *jet* black,* and of such a composition that it readily adheres to the leather. If for coloured goods, the ink or stain † should be of the same tint as the material.

The ink should be confined to the edges, and not be smeared over the face of the leather.‡ A fine, short-haired tooth-brush, protected by a metal plate either side, which reaches to within one-sixteenth of an inch to the edge of the hair, will be useful for this purpose.

The **Other Preparatory Processes**, such as the perforating of the toe-caps or vamps by means of perforating pliers or machine, marking imitation facings by means of a facing-marker, compass, or blunt non-cutting awl, demand careful attention prior to the fitting together of the parts.

The **Turning-in** of the edges of the vamps, quarters, or other parts would be done either by hand or machine. When executed by the hand-process a dull, blunt, short knife is often used. The work should be turned in evenly throughout its entire course. The turning-in may be to a dull-marked line, or by taking a regular amount from the cut edge. The turned-in portions of topbands and facings

* A good black ink may be made from a decoction of logwood chips, to which is added sulphate of iron and bichromate of potash. A little gum added will prevent spreading.

† Aniline dyes are useful for this purpose.

‡ To remove ink stains from fabric oxalic acid should not be used. Two parts of tartar with one part of powdered alum is more suitable.

should show a level bead of leather of uniform width. Machines are used for turning-in, some of them requiring work of a given shape, while others are adaptable for varying shapes. The best of its kind is the "Lufkin" folder. This machine cuts or nicks the edges, folds or turns them over, and compresses and flattens them. The edges may be to any shape, flat or curved. Work to be folded by this machine should have left on when cutting an even amount for turning-in, which is best done by having the patterns so made, and not by allowing on to a "raw-edge" pattern an amount which varies at the discretion of the cutter. Uniform skiving is also essential, and the width of skive should be twice that of the folded-in portion.

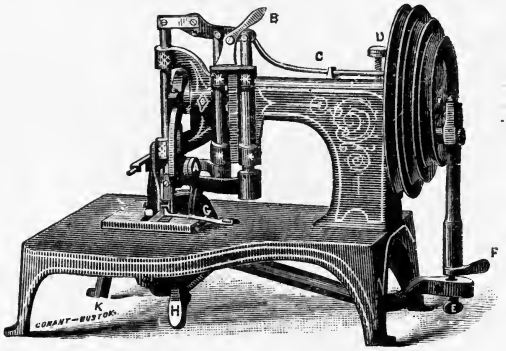

Fig. 188.

The "Lufkin" folder, or turning-in machine, is illustrated by Fig. 188. The following will give the principal parts:—

A is the nut that may be operated by the thumb. By lowering it, the knife may be made to give the cuts or nicks closer together or finer. This will be necessary in turning in smaller curves. If the nut is moved up, the feed, or distance, between the serration is greater. The feed on general work is set to give about 10 to 14 cuts to the inch.

B is the lifter used to raise and lower the feed-bars. It should be raised when placing the work to be folded.

C is the feed-bar presser-spring. The pressure on

the feed should be as light as possible, just sufficient to feed the leather.

The screw D will increase or decrease the pressure, the former only being desirable when the feed slips.

E is the ball-screw thumb-piece used to regulate the stroke of the folding-lever. It should be so adjusted that when the folded material is under the folding-lever, and the link on the driving-wheel is at its highest, the spring should slightly move. If it does not move, the nut F should be loosened, and the screw E turned in a little. If the folding-lever has too much pressure, the screw E is turned out of the balance-wheel connecting-link.

The gauge G is adjustable, and is used to regulate the width of the turned or folded edge. The edge of the leather to be folded is directed towards the guide-gauge; when inside curves are reached, such as the curve of a vamp, the material should be pressed harder against the gauge. When starting certain work, the work should be kept away a little from the gauge at first to prevent too wide a fold.

The right-hand lever, H, when raised up towards the operator, removes some of the pressure on the folding-lever, enabling a seam to pass without mutilation. The other lever, K, when pressed down, prevents the nicking of the work passing under the knife. It is used when the seam is under the knife.

The machine is run about 400 revolutions per minute, and the balance or driving-wheel has three grooved wheels, 5, 4, and 3 in. diameter respectively. The transmitter has corresponding grooved wheels, enabling the speed to be adjusted at will. The skived edges are coated with cement* and allowed to dry, being in condition when "tacky."

The knife requires careful attention. It should be sharpened on its bevel edge only, and the cutting edge kept perfectly square with the sides. It is adjustable, so

* Made from virgin rubber dissolved in naphtha, benzine, or bisulphide of carbon. It should be fine, and not too stringy.

as to go below the under-knife or cutter-block a sixteenth of an inch, and set so that the cuts are as near the folded edge as possible without being visible on the face. This especially so when on inside curves.

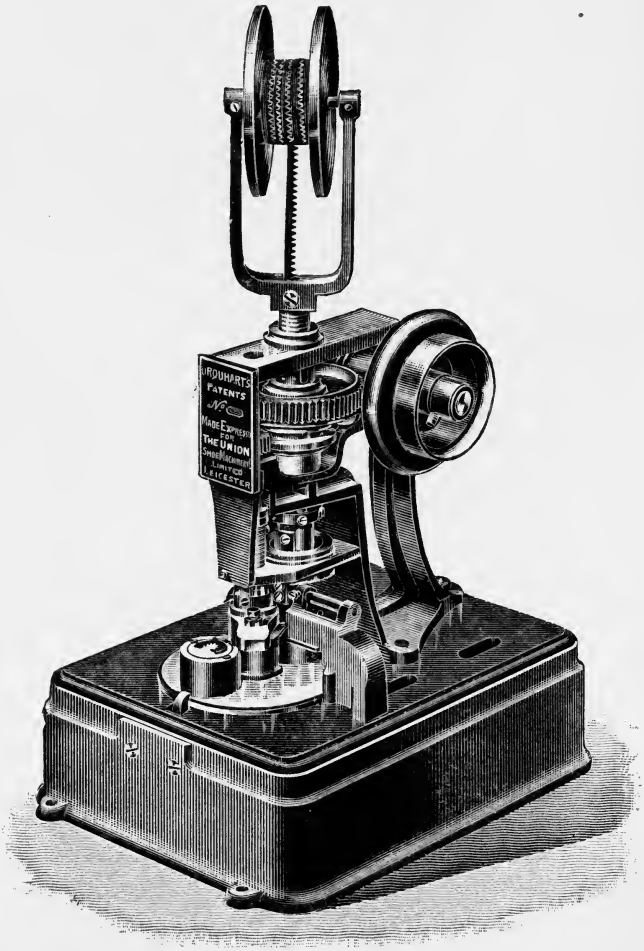

Fig. 189.

The under-knife or cutter-block should be sharpened on its front face where the knife passes. It must be kept

straight so that it may fit the knife, and must be adjusted *close* to the knife so that it may cut clean.

Button-Piece Beaders, etc.—The Urquhart button-scollop beader is illustrated by Fig. 189. It moulds and affixes the insertion beading to the shape of the scollop, and is a very useful machine to expedite button-work. Machines are also used for back-strap beading, and fancy-stitching perforators or flower markers, for indicating the design of flowering, if ornamental stitching be needed.

Adhesives.—The success of an adhesive used to unite two substances depends upon the manner of using quite as much as the pasty substance itself. Paste dries by evaporation, and therefore as little as possible should be used. The tenacity of an adhesive depends upon its intimate contact with the surfaces to be united. The chief obstacles to this are dirt and air. Air may be removed by rubbing the paste well into the surface and hammering. Sufficient time must be allowed for drying before stitching.

Paste is the term used to signify the homogeneous mass made by mixing the flour of cereals with water. Most of the farinaceous ingredients thus used consist of two substances, starch and gluten. Starch is insoluble in cold water, but when covered with boiling water the starch-cells swell, forming a glutinous mass. Gluten is a sticky, tenacious, brown mass, very liable to speedy decomposition. It is more adhesive than starch, although less durable. Starchy materials should be mixed to a *smooth* paste, boiling water being added, and the mass quickly stirred. To starchy pastes it is advisable to add glue, to increase the adhesiveness and stiffness. Preservatives are to be added to prevent decomposition.* Rye flour is rich in gluten, and is cheap. It makes a good paste. It should be quite smooth, and not lumpy. Alum is added in many cases when making, and, to prevent mould, some add salicylic acid.

* Carbolic, sulphate of quinine, oil of cloves, salicylic acid, oil of wintergreen, and boric acid, are used to prevent fermentation and as an insecticide.

Dextrine, starch gum, or British gum is used for leather purposes. It is soluble in cold or hot water. When dry it is very brittle, and, if excessively used, is the cause of broken and blunted needles. To lessen its brittleness, glycerine is sometimes added. Dextrine is more adhesive than flour pastes, and is disliked by vermin.

Cement is made from rubber. It is very adhesive, but must be allowed to dry somewhat on the leather before being put into contact with the other substance. It dries flexible, and is proof against insect life.

Cold-water Glue is made by mixing (*a*) and (*b*), putting the mixture in a steam bath until thoroughly incorporated—

(*a*) 1 quart water,
1 lb. fish glue.
The glue to soak in water all night.
(*b*) Dissolve 2½ oz. chloride magnesia,
„ 2½ oz. „ calcium,
in one quart of water.

Shoemaker's Paste is made by taking barley-meal and, with warm water, mixing into a thick paste. Hot water is added to bring it to the required consistency. It should then be placed in a warm place to ferment, which may be ascertained by the sour smell. This is a tenacious, smooth paste, free from lumps, and is a splendid adherent.

A paste may be made from gum dragon or gum tragacanth.

There are several proprietary pastes on the market, such as the "Sphinx Shoe Paste" and "Hedoral Gum."

For affixing patent beading, an adherent made by dissolving gelatine in acetic acid may be used.

Modes of Fitting.—Although the sequence of processes may differ in fitting, caused by the adoption or rejection of certain machines, the principles may be classified under two headings, "flat" and "round" fitting.

"Flat" fitting is the term used to describe processes

that, for the most part, consist in the fitting together of the various parts of the upper on a flat surface, which generally is a marble slab. This class is largely adopted for the women's trade, and great care is necessary that the parts are fitted with a due calculation for the alterations that are effected when the flat-fitted portions assume the rounder form of the upper, or when it is placed on the last. This mode of fitting is adopted for cheapness; but the general quality of the work produced is not equal to that produced by the round method. The linings especially are improperly fitted, a shortcoming that, with thought and attention, could be largely obviated.

"Block," or fitting-on-the-round, is used to denote the class of fitting where the parts are placed in position on a block or last before stitching. The "blocks" or "dummies" used are shaped in the top portion very similar to a boot-tree, but the bottom is made quite flat, so that it can stand firm on the bench or table before using. The last is used in some bespoke houses, where the "closer" is responsible for, and practically decides, the shape of the upper. Block-fitting is mostly used by the bespoke houses and for best men's trade.

A combination method is adopted with advantage in high-class factories, the linings, legs, etc., being fitted on the "flat," and the vamping or goloshing being executed by the "block" system.

The work fitted on the round or block has a much better appearance or set, and the materials used are less handled, than that fitted on the flat. The fit of the upper upon the last is greatly enhanced.

Rubbing Seams.—Whatever system is adopted, the closed seams should be well rubbed down so as to occupy as little space as possible, and also to present as little irregularity to the foot of the wearer. To this purpose seam-rubbers are used.

One type of seam-rubber consists of a cylindrical bar

of iron 16 in. long, and about $1\frac{1}{2}$ in. in diameter. Attached to one end of this bar is a handle, by which it can be rotated. The other end of this bar is fastened to a collar, which allows it to revolve. The collar is fastened to a pedestal, which also gives origin to an arm of the shape of the part required to rub down.

Machines are also used for this purpose, and either the "Rapid" or "Union" are good makes. The latter also ploughs or cuts out a welt if welted, as well as rubs down the seam. Fig. 190 shows a seam-rubber.

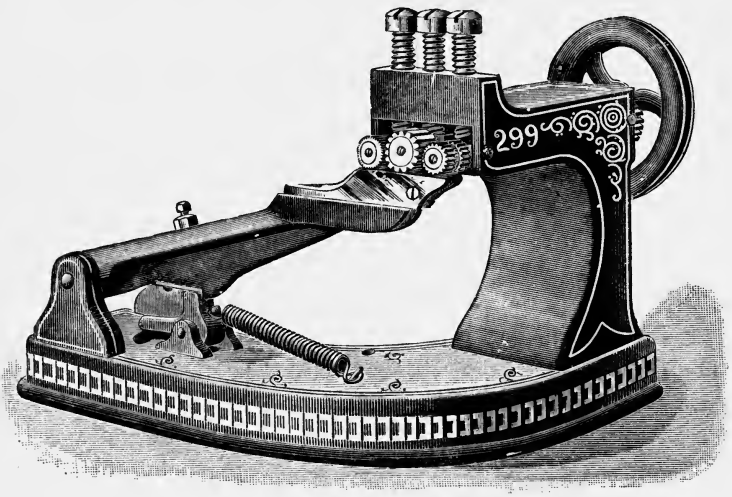

Fig. 190.

Treatment of Edges.—The edges of the various sections of the upper may be treated either—

(*a*) By leaving the lining and outside raw-edge, *i.e.* so that they are flush when stitched.

(*b*) By turning in the lining to show a level bead.

(*c*) By turning in the outside, and trimming off the lining.

(*d*) By inserting a bead between the outside and lining.

(*e*) By turning in both outside and lining.

If the edges are to be bound, they are done either by—

(1) The "flat-bound" method, where the binding is arranged equally to cover the outside and lining, that is, accommodated between the U-fold.

(2) The "bound-and-held-over" style — the binding being first stitched to the outside, and then well pulled over the lining and seamed.

(3) The "French-bound" method—the binding being closed to the outside and then well laid over, the lining being placed above the amount laid over, and, after stitching, trimmed off.

The "run-and-turn" or "bagged" methods are very similar. The face of the outside and lining are brought together and seamed as near to the edge as possible. It is then turned out and stitched again, giving a very similar appearance to that produced by method (*e*). This method of dealing with the edges is largely adopted to reduce the cost of turning in, and to obviate the use of paste during fitting.

Bagging Machines.—The machines used for rubbing the seams out for "bagged" or "stitched-on and turned-over edge" work are known as bagging or beading machines. There are two types in general use, the Watson and the Columbia. The former consists of a couple of fingers made to press out the seam, and on a line with this arrangement is the hammer for hammering same flat. The latter machine has the folding-out levers arranged in front of the anvil and hammer, enabling smaller curves to be operated upon with greater freedom.

Women's Laced Boots.—The sequence of processes of "fitting" a woman's lace boot on the flat is modified to suit the class of work and the stitching and other machines used. When the processes are greatly subdivided, it should be so arranged that there is no loss of time between each stage. The following order of procedure is given for paste-fitted work as an example:—

Fitting Process.	*Stitching Process.*
(1) Work skived and inked, facings marked.	(2) Seam closed of linings, webbed, strapped, or open-stitched as required.
	(3) Quarters closed, open-stitched (if required), and facings stitched.
(4) Topbands, facings, and side-linings pasted on.	(5) Topbands, etc., stitched on.
(6) Seams rubbed down and quarters fitted to linings. (If on flat slab allowance must be made at heel for stiffening substance and stretchiness of outside, etc.) Edges of fittings turned in.	(7) Quarters stitched round and lining seamed at toe.
(8) Stayed, and vamp fitted.	(9) Vamp stitched on and tongue included or treated separately.

Some prefer to punch the upper for eyelets before vamping, a plan to be recommended.

Women's Buttoned.—The button boot may be fitted on two plans, either by practically completing the button-piece before attaching to the quarter, or by attaching it to the quarter before completing the button-piece. The former method is generally liked owing to the trouble experienced in fitting the lining. If the patterns are correct, and for flat holes, the latter is the cheaper method, however. When the holes are worked the former is usually preferred. For paste fitting the following description will serve as an illustration :—

Fitting Process.	*Stitching Process.*
(1) Skiving, inking, button-holes,* etc., marked. Button-piece beaded.	(2) Lining closed, webbed-strapped, or open-stitched.

* Sometimes this is done in the cutting-room.

(3) Topbands fitted, side-linings.

(3*a*) Quarters closed and open-stitched. Button-piece stitched round and worked (if required), button-piece stitched to quarter.

(4) Topbands, etc., stitched. Lining seamed to button-lining.

(5) Lining fitted to quarter. Topband turned in.

(6) Stitched round, and toe of lining seamed.

(7) Vamp fitted.

(8) Vamp stitched.

ALTERNATIVE METHOD.

Fitting Process.	*Stitching Process.*
(1) Skive, ink, mark holes, etc.	(2) Close linings, web, strap, etc., close button-piece to quarter and close quarters. Open seam if required.
(3) Fit topbands and side-linings.	(4) Stitch lining to button-piece lining.
(5) Fit lining to outside, turn in topbands, and bead button-piece.	(6) Stitch round, and stitch to button-piece. Seam toe of lining.
(7) Bar and vamp.	(8) Stitch vamps.

Men's Laced Boots.—Men's work is fitted either on the flat, of which there are two modes of procedure—on the block, or by a combination of the flat and block methods. The following description of the operation will illustrate the fitting on the block:—

> After the work is skived, inked, etc., the linings are seamed, and, if required, webbed, backstrapped, or open-stitched. The topbands and facings are pasted and stitched on. The lining is now fitted to the block. The backs or legs are closed, rubbed down, stitched, or outside strapped. Outside or stitched facings are stitched. The lining is lightly pasted or quarter-leg pasted. The quarter-leg or back is fitted to the lining, hammered, and the turning in done. After drying it is removed from the last and run round. After again

putting on the block, the vamp is pasted on and afterwards stitched. The upper is punched and eyeleted before the vamps are pasted on.

A variation of flat fitting is often adopted for goloshed work, when stitched on a flat-bed machine, a brief description of which is given.

The parts are skived, etc., as usual. The topbands and facings are fitted to the lining, which must not be closed at the back. The quarter or leg is fitted, and the topbands, etc., turned in, and the quarter stitched round. The toe of lining is seamed, and the golosh fitted on, and closed to within an inch of the heel. The lining and leg is closed, and outside, inside-strap, and loop fastened, and the golosh stitching completed.

Men's Buttoned.—Like other designs, this boot may be fitted in several ways.

After skiving, inking, etc., the linings may be closed, backstrapped, topbands and button-lining stitched on, and stays for buttons pasted on. The quarters are now to be closed, etc., and the button-piece attached, and, if beaded, the bead affixed. It should then be placed to the lining and seamed round. Careful turning and rubbing out should be the next operation. The buttons should be sewn on and the front whipped up, and goloshed by one of the usual methods.

Fitting without Pasting.—To enable the best results to be obtained when holding the work while stitching, certain modifications in the pattern should be made over those usually adopted. The shaded portions in Fig. 191, A, show what is removed. The dotted lines indicate the topband and facings. If the patterns are intended to do duty for several substances of material, the lining at the heel must be left loose until lasting, when it is pasted to the strap and stiffener, obviating any pleats, which would otherwise be seen when this method is adopted in its entirety. The lining is closed as far as the golosh height, and the inside strap held on and stitched to a similar position. The

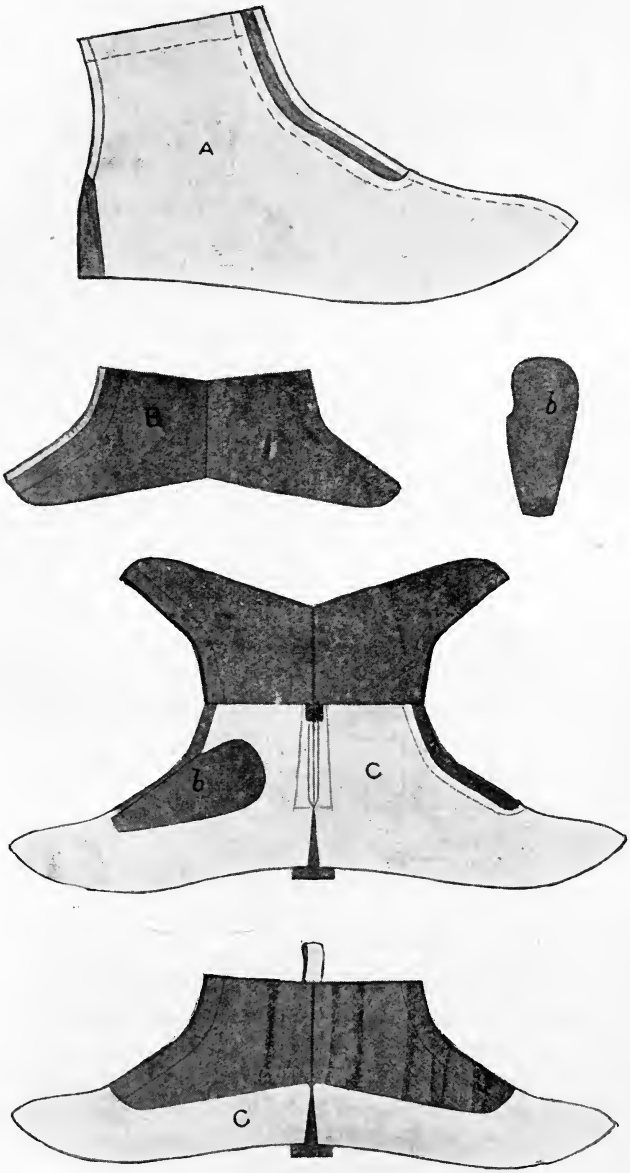

Fig. 191.

quarters B, Fig. 191, are turned in down the front, and the facing marked. The back is closed, etc., and the top stitched to the topband of the lining. The quarters are turned and run round, catching in the tongue (*b*) at one side (see C, Fig. 191). The golosh is capped, etc., and closed at the back, and placed carefully in position, and held on while stitching. This description will give an idea of the principle, it being modified according to circumstances.

Sewing Machines.—There are many varieties of machines for stitching uppers. Some only make one row of plain stitching at an operation, while others will make two, three, or more lines of stitching simultaneously. Machines of this class are of either the *flat-bed, cylinder, post,* or *pillar* description. Machines are also manufactured for automatically making fancy or ornamental stitches—such as half-chain, zigzag, overseaming, crewel-work, etc. Another type is used for making button-holes, lace-holes, etc. Motion may be derived from foot or power, the latter being obtained from steam, gas, or other engine. The use of electric motors has many advantages, especially when the stitching-room is located at a considerable distance from the main source of power, or where an irregular arrangement of the machines is required.

The essential mechanisms for the formation of a stitch are—

(*a*) Device for carrying thread through the material, viz. *the needle.*

(*b*) Arrangement for determining the length of stitch, viz. *the feed.*

(*c*) Appliance for taking the thread and forming the stitch, viz. the *looper*, or *shuttle*, or *rotating hook.*

(*d*) Contrivance for keeping thread or threads taut, viz. *the tension.*

(*e*) Arrangement for holding material in position while stitch is being formed, viz. the *presser* or *clamp.*

These results should be accomplished with the least possible strain to the sewing medium, whether it be silk,

thread, or cotton. The best type of machine is—other things being equal—that one which deposits the thread in the material stitched with the minimum of injury. Friction points should be carefully studied when making a selection, as well as the class of stitch given by the machine.

Stitches.—There are two types of stitches—the single-thread or *chain-stitch,* or the double-thread or *lock-stitch.*

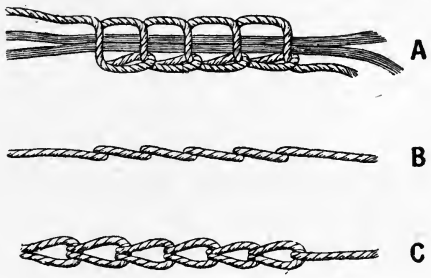

Fig 192.

With the former kind of stitch the thread * is deposited in the work with the least injury, and the seam made is elastic, even with such a material as cotton. The appearance of the stitch is different on the two sides of the work stitched. Fig. 192 shows a sketch of a chain-stitch of the

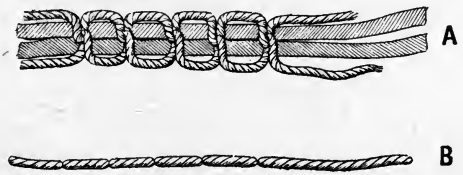

Fig 193

twisted-loop variety. A is a section of the material and stitch, B is the upper or right side, while C is the under or twisted-chain loop.

* This term includes silks, cottons, and threads proper.

The lock-stitch is formed by the interlocking of the under or second thread with that of the upper thread. The value of this class of stitch depends upon the accuracy with which the interlocking point has been adjusted to fall in the centre of the material. Fig. 193, A, shows a sectional view of the lock-stitch, the two threads intertwining as near the centre as possible; Fig. 193, B, gives the appearance of the top and underside of the stitch.

Formation of Stitch.—The chain-stitch is formed by interlooping a single thread beneath the work by a "looper." The action of this device may be by oscillations in a restricted arc, or by a continuous rotation. The needle, during the action of the machine, descends through the material, and with it goes the thread. When the needle has reached its lowest point it begins to rise, and the thread that has previously lain closely to the needle forms a small loop. The looper has been gradually approaching the needle, and the point is arranged to enter the loop when the needle has risen a little. The looper detains the thread, and spreads it while the needle is further rising. The second stroke of the needle is made through the loop previously made, and a chain is formed. The first loop is drawn up to the material while the looper detains the second loop. The action of the rotating looper is very similar to that of the vibrating one; only during the spreading of the loop a complete twist of the thread is given. This will be better understood by an examination of Fig. 194.

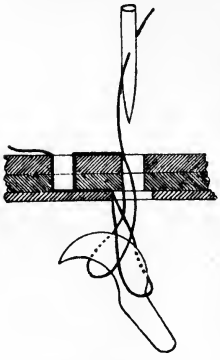

Fig. 194.

To form a lock-stitch a shuttle or rotating hook is used charged with *thread*, which is made to pass through the loop formed by the needle on its upward journey, or the upper thread is thrown over the spool containing the under thread.

The needle descends through the material, taking with it as before the sewing material, and when it reaches its lowest point begins to rise slowly. This causes a loop to be thrown, and the point of the shuttle enters this slack-loop, enlarging it and taking with it the under thread; and when the needle has returned to its highest point, a complete interlocking stitch is formed. This is illustrated

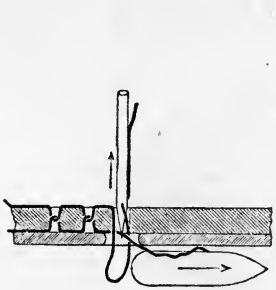

Fig. 195.

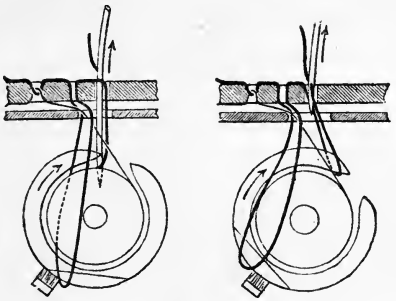

Fig. 196.

by Fig. 195. The formation of the stitch with rotary hook is very similar, and is illustrated by Fig. 196.

Needles.—The action of a sewing-machine depends upon the loops that are thrown out by the needle. Needles for leather work have two grooves, rendered necessary to carry through the thread, owing to the tendency of the material to close after piercing.

One of the grooves is longer than the other, and when setting the needle in the needle-bar, the *long* groove (Fig. 197, A) should be *away* from the point of the shuttle or hook. The short groove (Fig. 197, B) should always face the shuttle

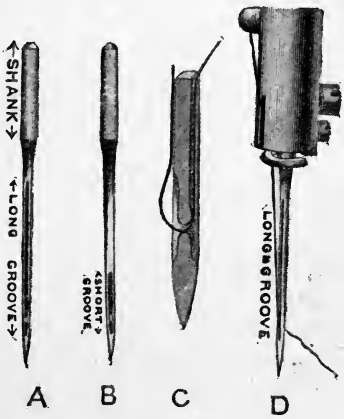

Fig. 197.

or hook point. The throwing of the loop (Fig. 197, C), for the looper shuttle or hook to enter, is performed by the latter groove. Similarly, when threading up, always thread *from* the *long* to the *short* groove (Fig. 197, D). The long groove protects the thread from undue injury during its passage through the material. Sufficient sewing material must be paid out through the eye of the needle to form a loop large enough for the shuttle or hook to pass through. After the passage, the thread must be again drawn through the eye of the needle, so that it is subjected to friction caused by the passing to and fro of the thread. The eye of the needle must therefore be perfectly smooth, and as large as possible in relation to the size of the needle.

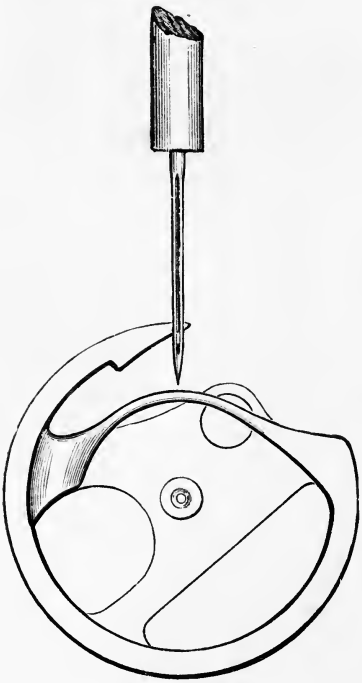

Fig. 198.

If the needle eye be too large for the size of the thread, the machine will miss stitches; and similarly, if it be too small, the thread will be broken.

In most of the machines the needle is self-setting, and in such cases the shank should be inserted right to the top of the hole in the needle-bar. In the machines illustrated in Figs. 221 and 222, the needle should be set to the file-mark on the needle-bar. Care should be taken with the hook machines that the needle is set correctly, because if too low it is likely to damage the hook. When correctly set, it should have the same relation as that shown by Fig. 198.

When a rotary presser-wheel is used the threading may be facilitated by placing the end of the thread in the groove of the needle, and lowering the end until it enters the eye, as illustrated by Fig. 199.

When extra hard twisted thread is employed, it is sometimes advisable to slightly turn the needle, so that the loop may be thrown squarely on the hook of the

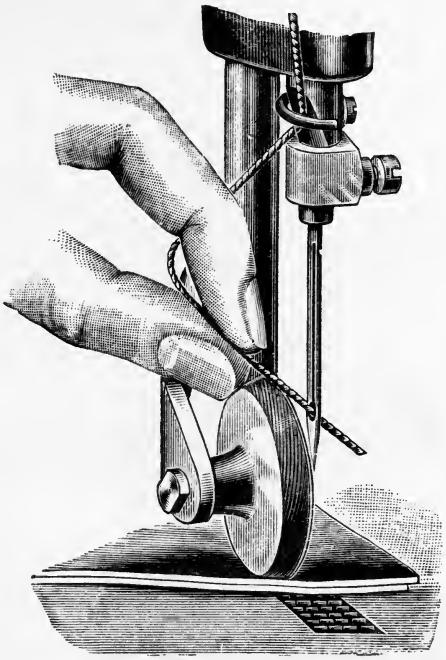

Fig. 199.

shuttle. A reverse twist in the thread will be treated in a similar way, but the needle will be slightly turned in the other direction.

The point of the needle must be sharp, and for leather work the points are chisel-shaped, instead of taper or round, as those used for fabric. The chisel-shaped or flat point is variously positioned in relation to the direction of the eye of the needle. The direction of the cutting or piercing

point of the needle in relation to the line of stitching very largely determines the appearance of the stitch when deposited in the work. For various kinds of work differently pointed needles are selected. For a "pearly" stitch the point used is one that spreads the stitch and punctures the leather more or less transverse to the line of stitching; but for a sunken stitch for heavy or stout work, or for work that has to be "hammered off," a needle that cuts the slit parallel to the line of stitching is required.

For cloth, linings, fabrics, and sometimes for light leathers, a needle with a round point (●) is used. This kind of needle is also advisable for stitching elastic gussets. Needles that perforate thus / are used for work where the stitch is required to be well drawn to the leather. When a face stitch is required, giving what is sometimes known as a "pearly" stitch, a point is selected that makes a cut thus —. If the stitch is required to be more sunken than the point that cuts \, points should be used that puncture thus |.

Various names are given by the makers for the points of their needles; for instance—

The "W. & W." names are—

	Flat.	Cross flat.	Spear.	O.S. Twist.	Reverse. Twist.
that cut	—	|	♦	/	\
and used for	Face stitch.	Sunk stitch.	Sunk stitch.	Sunk stitch.	Sunk stitch.

The "Singer" names are—

	Round.	Twist.	Reverse.	Wedge.	Cross.
that cut	●	\	/	—	|
and used for	Elastic and fabric.	Sunk stitch.	Drawn stitch.	Flowering or face stitch.	Sunken more than "reverse."

The Bradbury Co. use the following:—

	Flat or chisel.	Twist.	Cross.
that cut	|	/	—

The point of the needle may be named in reference to

the direction it takes in relation to the needle-eye plane, and would be as follows :—

The direction of needle eye
„ "leather" point would cut /
„ "reverse" „ —
„ round or cloth „ ●

The size of a needle is known by a number, but unfortunately there is not that uniformity in size desirable among the makers. This can be seen by making a few tests,* either using Stubbs' gauge or a micrometer. Perhaps this variance partly accounts for the fact that, with a given number of needle, various closers employ various sizes of stitching material. The point to bear in mind when selecting a needle to use with a given "thread," is to choose one that punctures a hole that will be well filled up when the thread is deposited in its place. The nature of the stitching material will also influence the selection, as the softness of silk will enable a smaller-sized needle to be used when compared with a similar substance thread.

Feeds.—Some arrangement must be provided to move

* The results of a few tests taken at the eye of the needles are here given—

Wheeler's	No.	4	needle	= 59	Stubbs' gauge.
„	„	5	„	= 58	„
Jones' (Hollington's make)	„	½	„	= 59	„
„ „	„	2	„	= 67	„
„ „	„	3	„	= 60	„
„ „	„	4	„	= 58	„
„ „	„	5	„	= 56	„
„ „	„	7	„	= 53	„
„ „	„	8	„	= 51	„
„ „	„	10	„	= 48	„
Singer's (Hollington's) ...	„	0	„	= 60	„
„ „ ...	„	½	„	= 59	„
„ „ ...	„	1	„	= 58	„
„ „ ...	„	1½	„	= 56	„
Jones' (Perkins')	„	2	„	= 67	„
„ „	„	3	„	= 60	„
Singer's (Company's) ...	„	0	„	= 59	„
„ „ ...	„	1	„	= 56	„
„ „ ...	„	1½	„	= 55	„

along the work by given amounts in perfect regularity, thus determining the length of the stitch. This motion must be automatic, and not dependent upon the operator beyond the determination of the amount of feed for the work from time to time. There are several mechanical ways of performing this.

The *four-motion* feed may be either a *top-feed* or an *under-feed.* In the *top*-feed the pressure and motion is applied from above by means of a serrated foot, controlled by a spring. The four motions consist of—

(1) Application under pressure of foot to material, to clamp it as it were.

(2) The movement of the foot with the work, the determined amount to settle the length of stitch.

(3) The foot lifted from the work.

(4) The foot returns ready for repetition of motion (1).

This style of feed can be found in machines constructed for flat binding, patching, repairing, etc., and is a feature of the machines illustrated on pp. 287 and 288 by Figs. 221 and 222.

The four-motion *under-feed* consists of a device under the work, pressure being continuously delivered from above by lowering the presser foot before commencing to sew. This enables the operator to turn the work while the needle is in it, using it as a centre to sharply turn when required, following the contour of the part being stitched.

The motions of the under-feed of this type are as follows :—

(1) The feed rises, and its serrated surface enters or presses up to the under side of the material being stitched.

(2) The feed, together with the work, moves forward the afore desired amount, thus deciding the length of the stitch.

(3) The teeth of the feed is lowered out of contact with the material, which is held in position by the top pressure.

(4) The feed returns ready to perform motion (1).

Passing by the "drop-feed" and "draw-feed," the

wheel-feed requires notice. This consists of a wheel whose periphery is serrated, and it is so arranged that it projects slightly above the plate, and thus engages the material that is pressed upon it by the foot above. The wheel revolves a given amount, as determined by the throw of the pawl. Fig. 200 is a sectional view of a wheel-feed, showing also

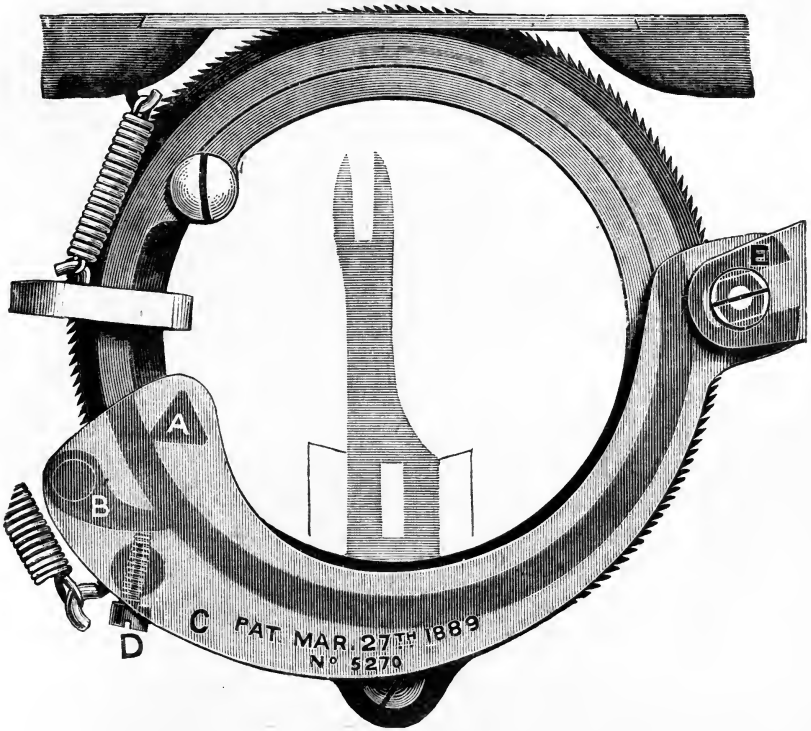

Fig. 200.

Jones' patent arrangement for compensating for the wear of the stud.

Shuttles, Hooks, etc.—The appliances for taking the thread and forming the stitch known as a chain are termed loopers. Shuttles are contrivances for containing the spool or bobbin of under stitching material in a lock-stitch machine, and are of various kinds. They must be in any

case perfectly smooth so as not to chafe the thread. The weavers or boat-shaped shuttle, familiar to most folk, is chiefly used for a type of motion known as *reciprocating*.

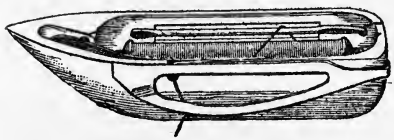

Fig. 201.

The reciprocating shuttle is illustrated by Fig. 201, and travels with the race lever to and fro in the same plane. Owing to the reversing at the conclusion and beginning of each complete motion, it is a form of motion only adapted with a limited range of speed. This type of shuttle is one that allows the stitching thread to be deposited with the minimum of friction caused by the see-saw passage through the eye of the needle. Less thread is paid out and taken round this form of shuttle than in any other. The amount of thread paid out as slack would be about 1½ inches. Its objection is that the tension or strain on the thread varies as it is delivered from the centre or end of the spool, amounting to nearly 50 per cent. more strain when delivered from the ends.

For a good appearance stitch, where speed is not a vital consideration, this form of shuttle answers every requirement. Machines with reciprocating boat-shaped shuttles are not usually provided with independent take-ups, owing to the small amount of "slack" needed for the shuttle to

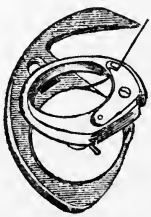

Fig. 202.

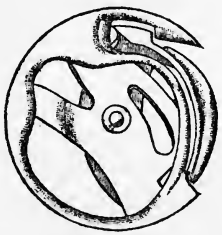

Fig. 203.

pass through. The machines illustrated in Figs. 221 and 222 have this form of shuttle.

The oscillating shuttle is shown by Fig. 202. This shuttle contains a disc-shaped spool or bobbin, that relatively contains a large amount of thread, and is freer from the angular strain when delivering the thread. The motion is a to-and-fro one, in a restricted arc of a circle. The machines illustrated by Figs. 213 and 219 have this type of shuttle.

The rotary hook is now extensively used for sewing-machines, and is illustrated by Figs. 203 and 204, the latter

Fig. 204.

also showing the bobbin case in position. It throws a twisted loop, and, owing to the size of the hook, takes a large amount of slack. Machines illustrated by Figs. 205 and 215 have this type of shuttle.

The rotary shuttle is a form not much in use, but is illustrated by Fig. 206. The block (Fig. 207) shows the spool or bobbin case closed, while Fig. 208 shows the same opened and the case removed. The bobbin case is also shown by Fig. 209.

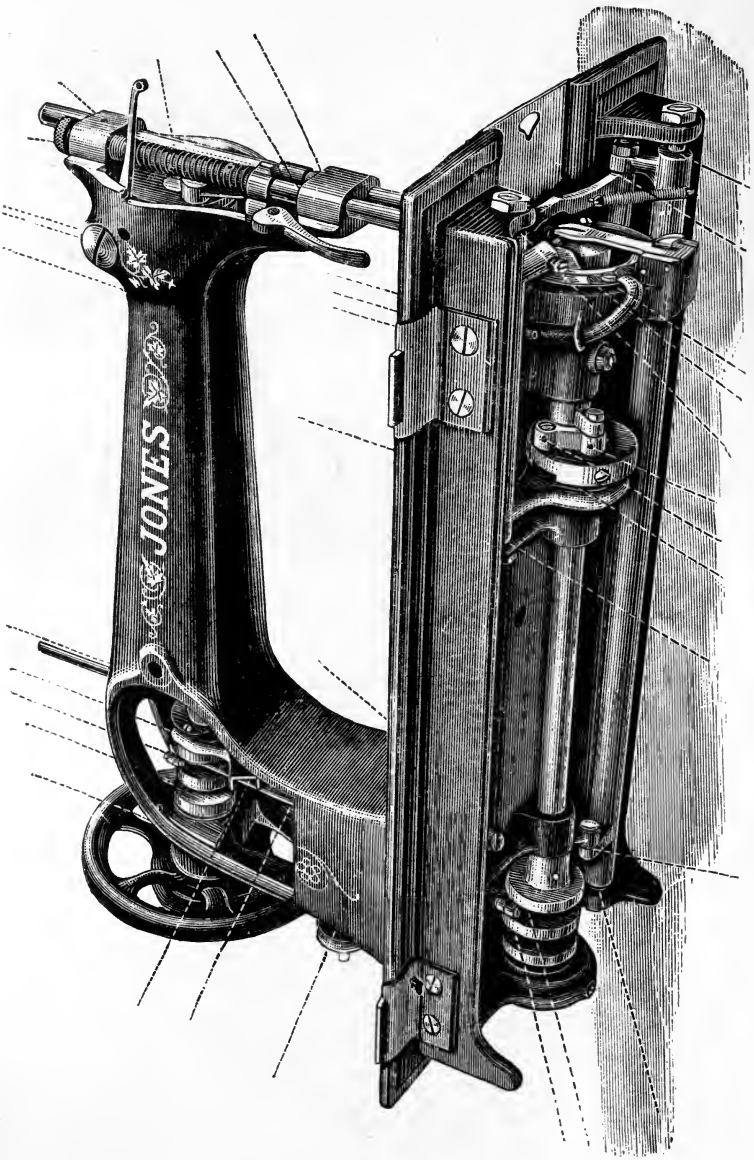

Fig. 205.

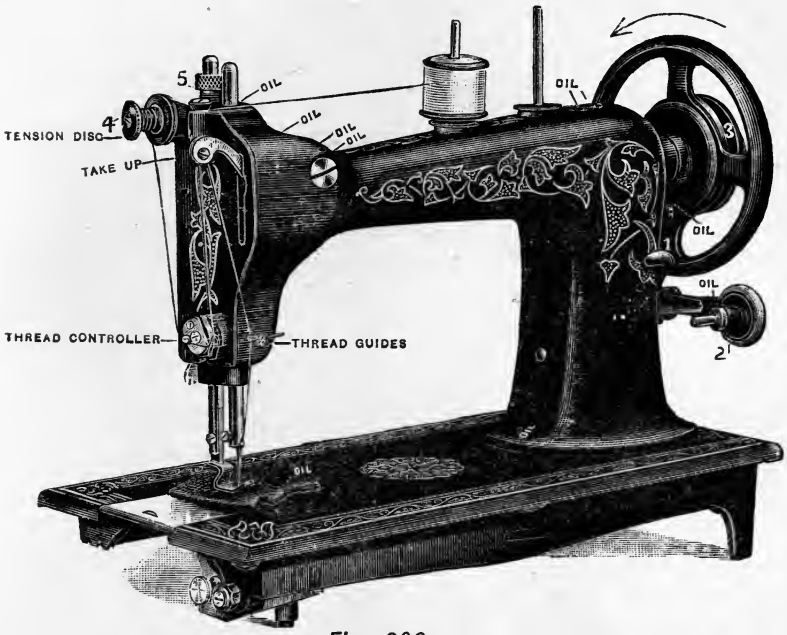

Fig. 206.

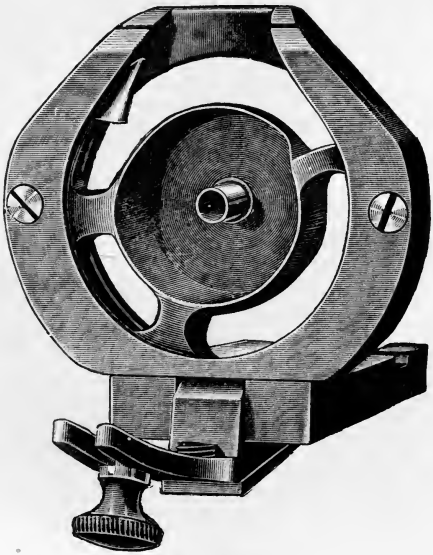

Fig. 207.

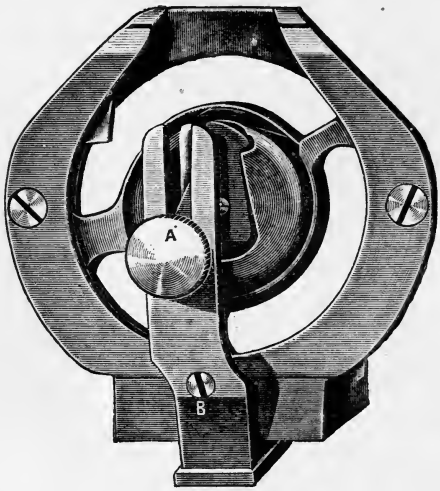

Fig. 208.

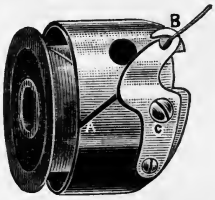

Fig. 209.

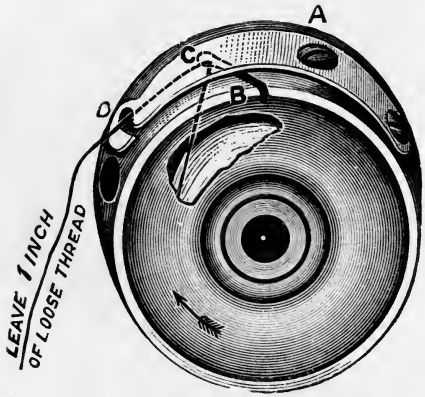

Fig. 210.

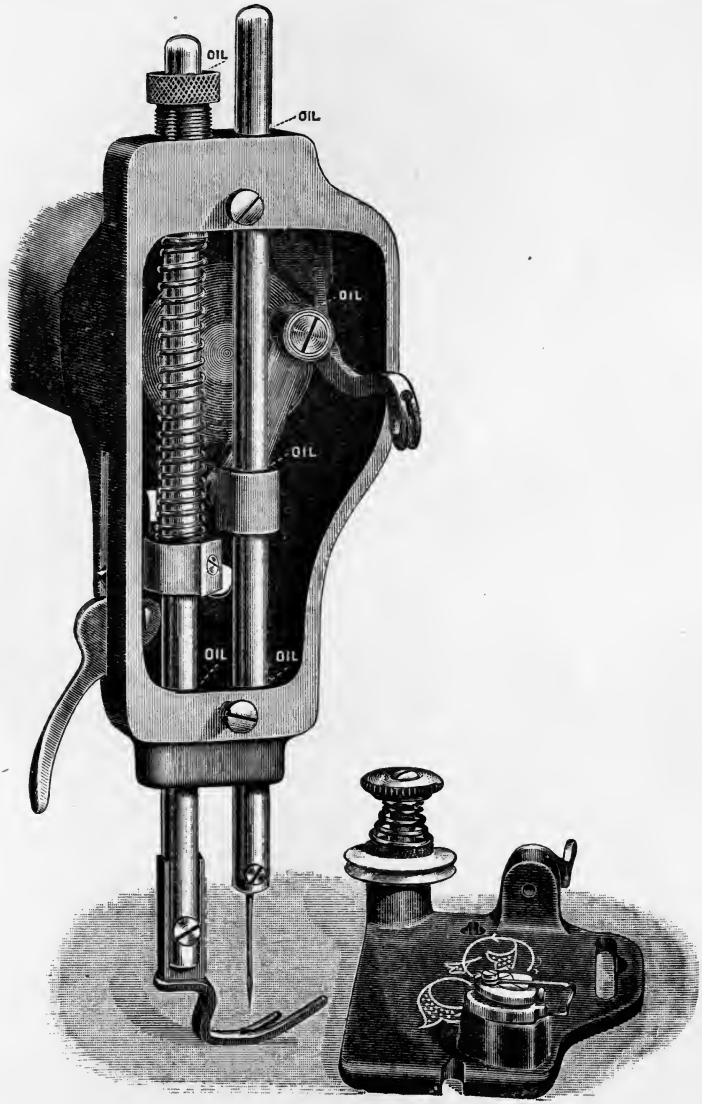

Fig. 211.

Tensions.—The tensions or tautness placed upon the threads may be either upper or under. The upper tension is

arranged by the thread passing between two discs known as tension discs (B, Fig. 212). The lower is regulated by a spring in the shuttle, actuated by a small screw, A, in Fig. 210. A perfectly uniform tension of the two threads is essential, so that the lock may take place in the centre of the material stitched. In high-speed machines the under tension is kept as constant as possible, the bulk of the adjustment being performed with the top tension.

Pressers may be either a foot or wheel variety, or may be vibratory. The spring pressure keeps the work upon the feed, and it can be readily understood by an examination of Fig. 211, where the face plate is shown removed, thus exposing the spring, etc.

Take-ups.—Where the amount of slack paid out through the eye of the needle is greater than the amount of the dip of the needle-bar, an independent take-up is required. Its function is to pull up the loop after it has passed round the shuttle, or the hook has passed through the loop. D, in Fig. 212, is the take-up, and, *en passant*, it is to be noted that it should be always brought to its highest point before commencing to stitch, or before removing the work from the machine.

Check-springs.—These are sometimes termed thread controllers. They act as safety-valves, and if they are too stiff or light the stitches slip, and if too weak the thread is troublesome to work.

Threading up.—This can be readily understood by reference to Figs. 206 and 212, and thus needs no further comment.

Direction of Motion.—The balance wheel should revolve *away from* the operator in Bradbury's No. 8 (Fig. 206) and in the Singer Left-hand Cylinder machines (Fig. 219). It should revolve *towards* the user in Jones' improved (Fig. 205), Singer's I.M. (Fig. 213), Singer's Right-hand Cylinder, Singer's Buttonhole (Fig. 218), and Wheeler and Wilson's (Fig. 215). The wheel should turn from left to right as the hands of a clock in Thomas' circular head (Fig. 221) and Thomas' leather machine (Fig. 222).

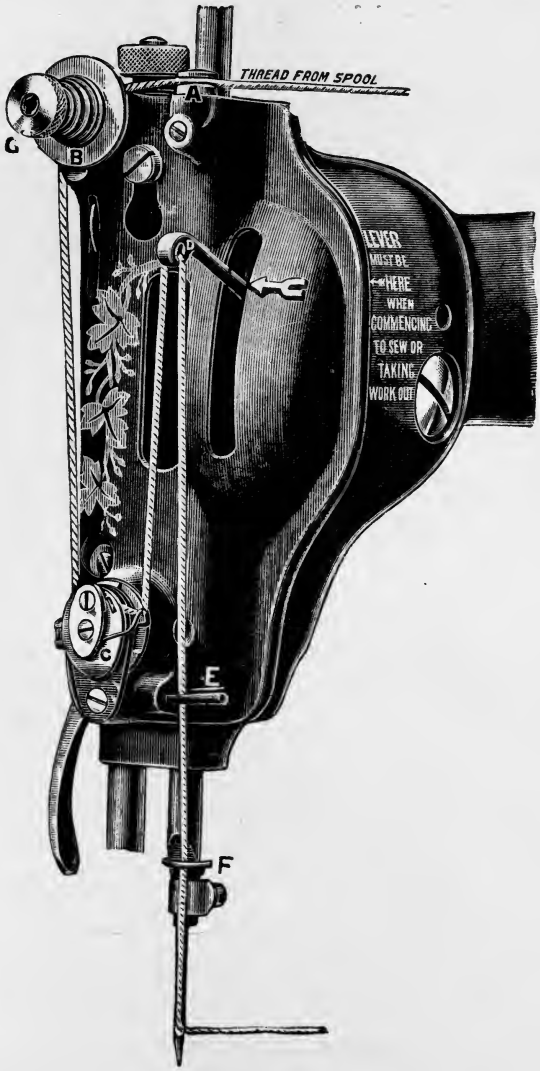

Fig. 212.

The speed of running the machine is dependable upon whether it be a chain or lock-stitch; the kind of shuttle, reciprocating, oscillating, rotary hook, or rotary; and the

tension, materials, and friction points. The finer the needle and thread, other things being equal, the higher the speed. The reciprocating shuttle machine may be driven up to 200, while the oscillating may be driven up to 300 per minute.

The average speed for leather work may be said to be from 200 to 350. Some of the special machines may be driven at a very much greater rate of speed.

Threads, Silks, Cottons, etc.—Threads for upper stitching and other purposes should be composed of long fibres, free from kinks or knots. It should not be too loosely or too tightly twisted. The "twist" must be carefully selected for the particular kind of machine, an improper twist causing missed stitches, the loops being thrown on one side, thus preventing the shuttle or hook entering. Threads are reverse twisted for the Singer and Wilson machines, and rightly twisted for such machines as Jones B., Howe, and Thomas. There are generally three closing agents used, viz. silk, cotton, and thread. Their merits may be briefly summed up as follows: Silk has much elasticity, is of good appearance, is soft, and lends itself easily to the passing through the various threadways. The tensile breaking strain for No. 16 would be about 5 lbs. for black dyed, whereas for white it would be about 6 lbs., while for yellow or natural colour it is about 7½ lbs. Silk stands least abrasive friction of either three agents.

Cotton is a hard, smooth, surfaced agent with practically no stretch. It has the highest power of resisting abrasive friction. It is used for cheapness and strength. It does not present such a nice appearance as silk, and is troublesome to work, although the selection of a "soft finish" much removes this difficulty.

Thread is the most troublesome material used for closing. It is strong, and has the medium amount of power to abrasive friction of the three under notice. It is largely used as a bobbin thread, with silk as a top one. On account of its hardness, it takes a larger needle than a similar size in silk. The following table will show—

Size of needle.	Size of silk.	Cotton.	Thread.
½ ...	20–24 ...	— ...	—
1 ...	18–20 ...	40 ...	80
1½ ...	16–18 ...	30 ...	70
2 ...	12–14 ...	20 ...	60

For light materials, such as glace, a needle of 0 size with 22 silk may be used, while for calf kid and similar substances and matured leathers, ½ with say 22 silk may be used. The quantity of silk for a given length of seam can be approximately calculated thus—For each yard of seam by lock-stitch, about 2½ yards; for each yard by chain-stitch, about 4½ yards.

To make a good solid seam, "hammering off" should be resorted to, to close the holes made by the needle.

The Mechanical Points that require attention when the selection of a machine is under consideration are—that the needle-bar is free from play laterally; that the shuttle works freely, but not too cramped; that the feed-wheel (if used) is positive; that the presser-foot is rigid, and set as close to the needle as possible; the amount of slack thread be paid out through the eye of the needle for passage over the shuttle or hook; the take-up (which must be independent, pulling up the thread after the needle has left the material) and its position; the friction points to be passed when threading up; the size of the bobbin.

Special Machines.—These comprise a very large variety. In the *flat-bed* type there are machines that perform almost every kind and combination of stitch or stitches that can be desired. Various attachments are affixed, such as trimmers, guides that enable a large quantity of work to be put through. For instance, the High Speed Singer is shown in Fig. 213. To this can be attached a trimmer for trimming the seam at the same operation as that of closing. Two or more needle-bars can be provided, performing the same number of rows of stitching as the number of needles provided. By causing the horizontal movement of the needle-bar, some two dozen varieties of stitches may be produced. Figs. 214 and 214A show the head and under

Fig. 213.

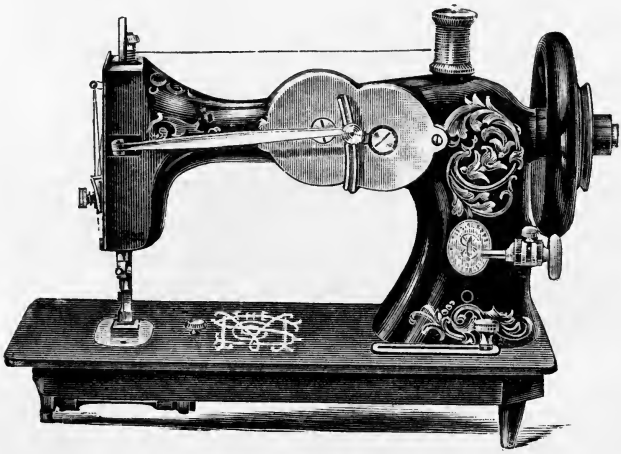

Fig. 214.

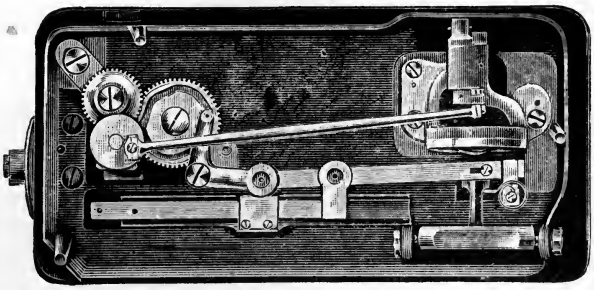

Fig. 214A

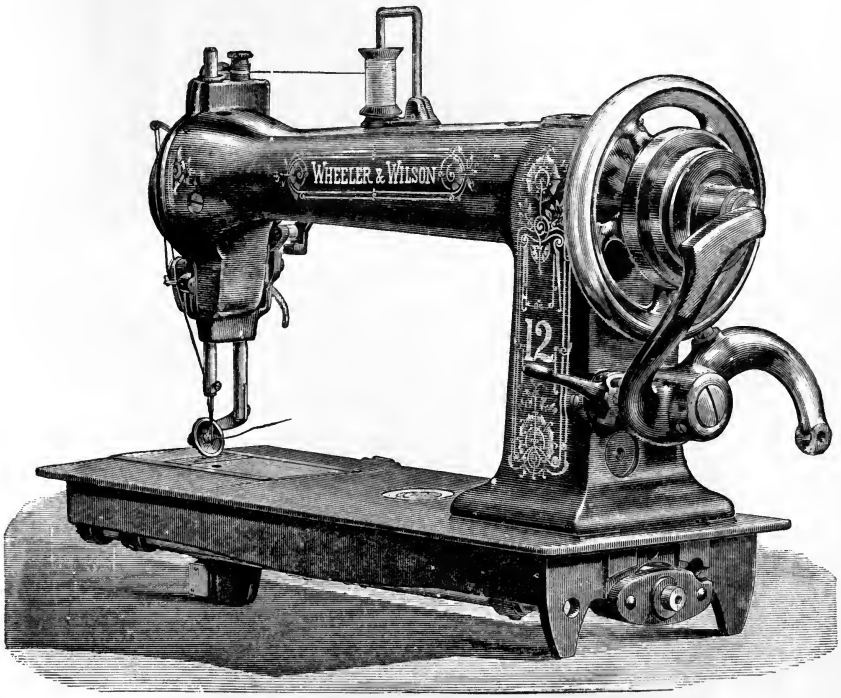

Fig. 215.

view of a Singer No. 32 machine, which makes some 33 varieties of ornamental stitches. Fig. 215 shows a Wheeler machine which can also be arranged for various purposes.

Trimmers, one or more rows, etc., are among the arrangements.

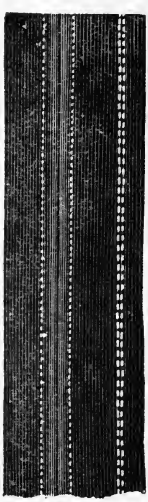

Fig. 215A.

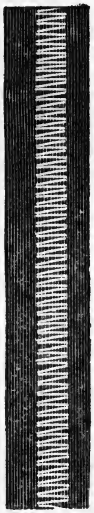

Fig. 215B.

Fig. 215C.

Fig. 215D.

In Figs. 215A, 215B, 215C, and 215D, are shown a sketch of two rows, over-seam and variety stitch respectively. These classes of machines can also be arranged for working lace-holes (Fig. 216), and the latter illustration shows some seven holes worked upon a Wilson machine. Fancy patterns or crewel work can also be produced upon Wilson machines, as shown by Fig. 217.

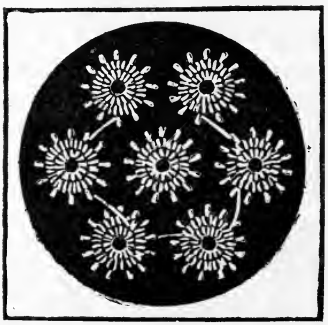

Fig. 216.

Button-holes can be worked either upon a Reece, which is the best for speed, or upon a Singer. Fig. 218 shows a Singer driven by foot-power.

Cylinder machines are useful for goloshing and stitching

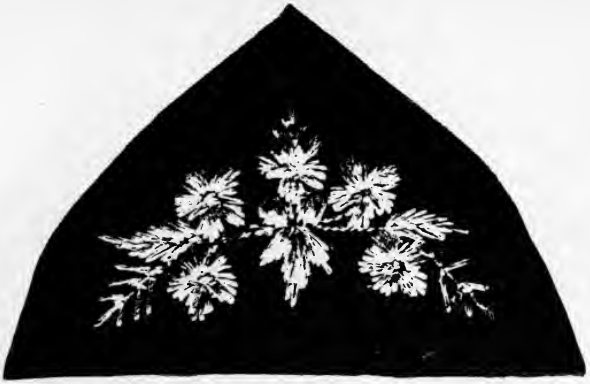

Fig. 217.

Fig. 218.

work put together without previous pasting. Fig. 219 shows a sketch of a Singer R.H. machine.

Pillar or post machines are also very useful when adopting the method of closing referred to on p. 260.

One of the high-speed, vertical hook machines is shown in Fig. 220, and Fig. 220A shows the hook and spool and

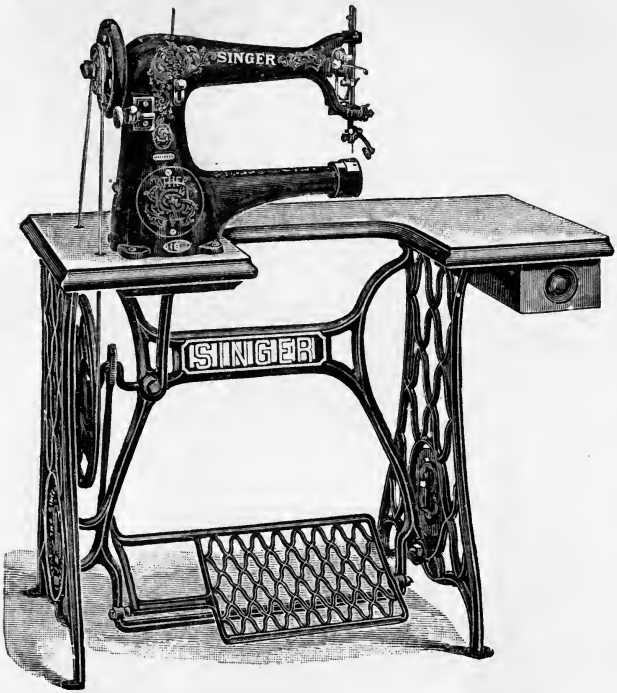

Fig. 219.

vertical shaft that imparts the motion to the hook.

The Thomas circular head or universal machine is so constructed that the "mover" or presser-foot can be made to work in any direction required. It is useful for pulling in elastics, putting on toe-cap patches, etc., and is shown in Fig. 221.

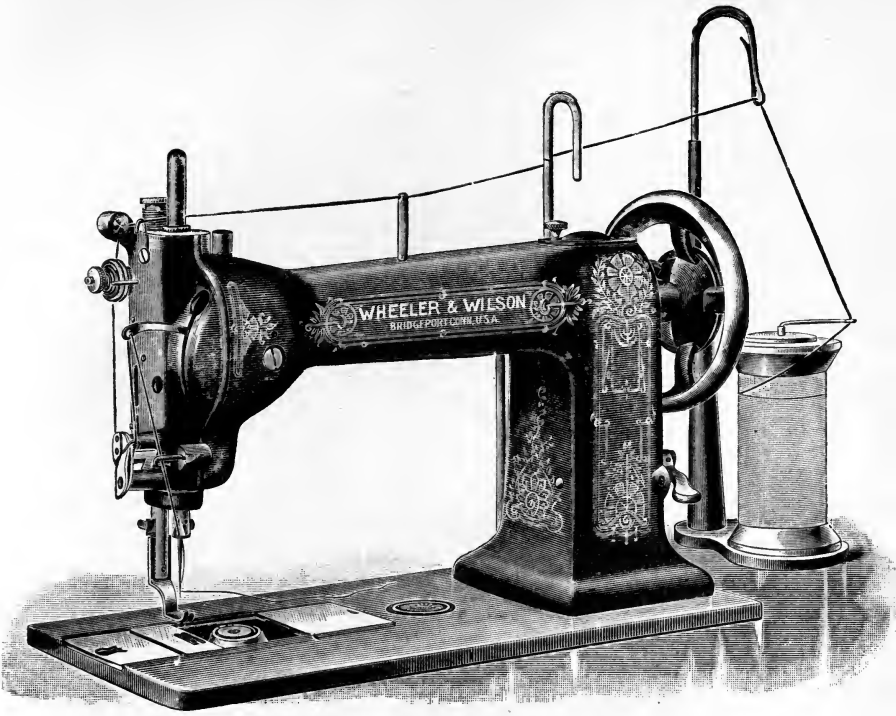

Fig. 220.

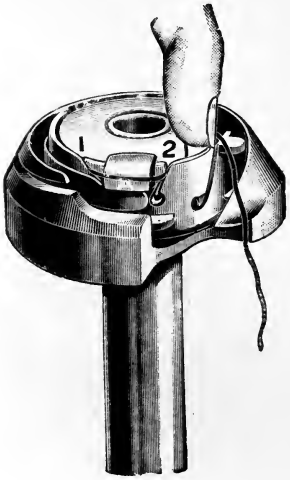

Fig. 220A.

Fig. 221.

The reciprocating shuttle leather machine of the same make is shown in Fig. 222.

Fig. 222.

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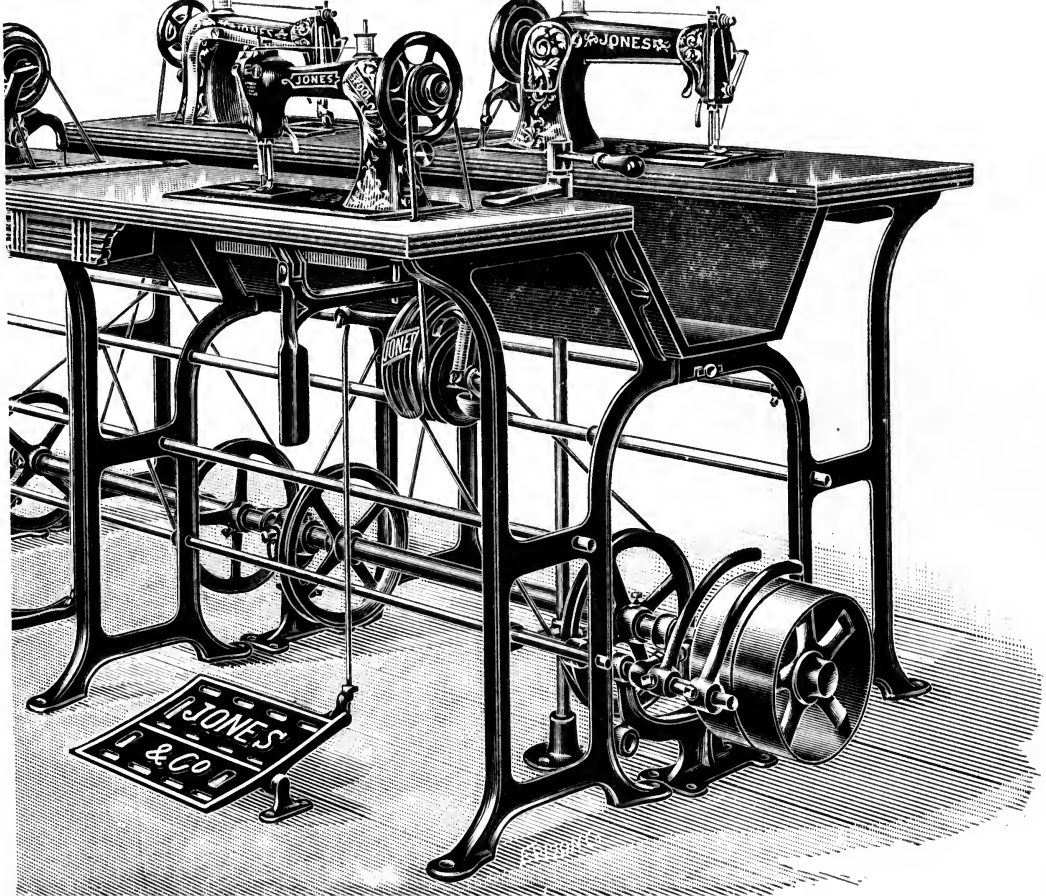

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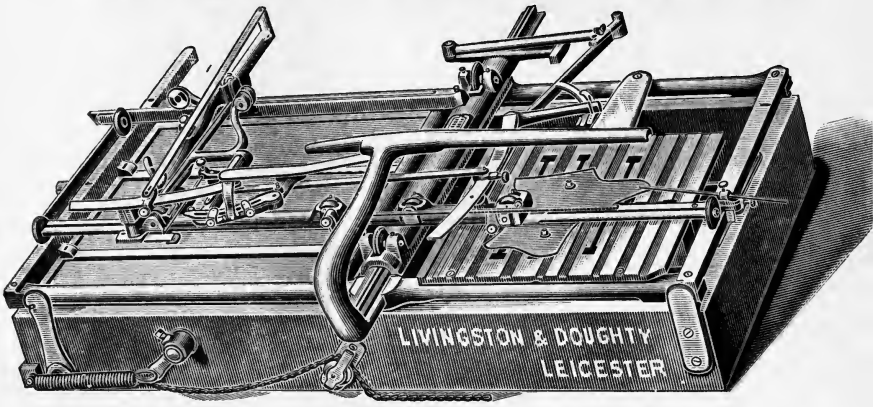

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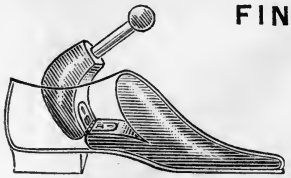

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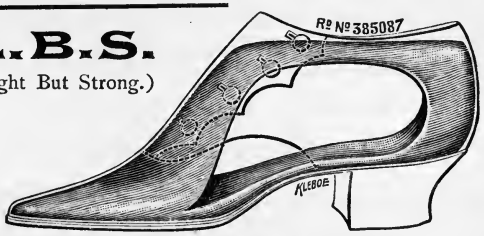

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